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Old Age Security Program Mortality Experience

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Foreword

Like many countries, Canada has experienced a population that has been aging at an increasing rate. The aging of the Canadian population has increased especially since the inception of the Old Age Security (OAS) program in 1952. Increasing life expectancies, the aging of the baby boomers and fertility rates that have been below replacement levels for some time are the predominant factors that have contributed to a large increase in the proportion of elderly in the Canadian population, and this increase is expected to continue over the next 30 to 50 years. As a result, the population at ages 65 and over is expected to more than double from 2003 to 2030, and as a proportion of the total population will grow from 13% of the population to 23% by 2030 and then to 25% by 2050. Older age groups will experience even higher rates of growth. As an example, those aged 85 and over, which now represent 1.5% of the population, are expected to represent 2.7% of the population by 2030 and 5.1% of the population by 2050. An increasing proportion of elderly will create challenges especially in the financing of social and health programs that are financed from general tax revenues. Under the OAS program, which is financed from general revenues, the number of recipients of the basic pension is expected to more than double from 4.0 million in 2003 to 8.9 million in 2030.

Historically, the level and age trajectory of mortality rates at advanced ages in Canada have not been readily and precisely measured due to problems concerning the reliability of data on deaths and on population counts beyond a certain point in official vital statistics. For instance, Life Tables for Canada (LTC) published by Statistics Canada are based on Census data and on the national system of vital statistics. As the OAS program provides the payment of old age basic benefits to almost all Canadians aged 65 and over, the availability of an administrative OAS beneficiaries database allows the more accurate measurement of the level and trend in mortality experienced by the oldest portion of the Canadian population. This study will indicate how current trends in mortality at older ages compare with past trends and how the resulting shape of the survival curve is changing as income increases.

Intuitively, individuals with a higher standard of living are expected to experience lower mortality than those with a lower standard of living due to an overall healthier lifestyle combined with a higher income. In addition to studying the overall mortality of older Canadians by age and sex, this study also analyses mortality in terms of income, which is the most common variable used in defining an individual's socio-economic status. For this study, the measure of income was determined from the type and amount of monthly OAS program benefits received over the period of the study. These benefits include the cases where the basic OAS benefit was reduced by the clawback provision because of high income or was increased through the income-tested Guaranteed Income Supplement (GIS) because of low income.

I. Executive Summary

A. Purpose

This study is the second mortality study published by the Office of the Chief Actuary (OCA). It presents estimates of the level of mortality as measured from the mortality experience of Canadian resident beneficiaries of the Old Age Security (OAS) program who were aged 65 and older in the period running from 1 January 1999 to 31 December 2003. The OAS database used for this study reflects over 19 million life-years of exposure and about 860,000 deaths. The volume of data permits the study of the level of mortality experienced at the advanced ages with more accuracy and reliability as compared to other sources of information.

The mortality experience of OAS program beneficiaries is first evaluated on an overall basis and then by a classification of subgroups that takes into account place of birth, the type and amount of OAS benefit paid over the experience period for each individual. It is possible to distinguish those beneficiaries with high incomes as their level of basic OAS pension received is reduced through a provision of the *Income Tax Act* often referred to as the "clawback provision". Similarly, it is possible to distinguish beneficiaries with low incomes as their basic OAS pension paid is increased by the Guaranteed Income Supplement (GIS) by different amounts depending on whether they had little or no income. The mortality experience of the OAS subgroup that resides in Canada less Québec is also analyzed, specifically between those receiving a Canada Pension Plan (CPP) retirement benefit and those not receiving the benefit.

As the 2000-2002 Life Tables for Canada (LTC) were not yet available at the time of this study, the OAS mortality experience was compared to a benchmark mortality table that was derived by projecting the 1995-1997 LTC mortality tables to the year 2001 based on mortality improvement rates experienced between 1996 and 2001. The life expectancies at age 65 resulting from the projected 1995-1997 LTC compare well with figures published by Statistic Canada for the year 2001. This benchmark mortality table is also the starting point for the mortality projections of the 7th OAS Actuarial Report on the Old Age Security Program as at 31 December 2003 ("7th OAS Report").

The OCA will use the results of this study to assess the mortality of the overall Canadian population and the CPP and OAS beneficiaries when producing its next triennial actuarial reports on the CPP and OAS.

B. Scope

Section II presents an overview of historical Canadian population trends as presented in the 7th OAS Report. Section III presents a summary of the data and methodology used to determine the mortality rates experienced by OAS beneficiaries over the period 1999 to 2003. A detailed analysis of the results is then presented in Section IV. Section V presents life expectancies at age 65 while Section VI presents the mortality improvement rates for each subgroup of beneficiaries. The conclusions of the study follow in Section VII. Lastly, various appendices in Section VIII provide statistics and further details in respect of the methodology used, and list the references used and contributors to this study.

C. Main Findings

- The oldest OAS male beneficiary in pay in 2003 is 110 years old and the oldest female beneficiary is 112 years old.

- The overall mortality of OAS beneficiaries in Canada is 7% higher for males and 6% higher for females relative to the 2001 mortality table used in the 7th OAS Actuarial Report. The mortality difference is especially higher for the 85 to 89 and 90 to 94 age groups for both sexes.

- Male OAS beneficiaries experience mortality rates that are 72% higher than for females at ages 65 to 69. The gap in mortality rates between males and females decline significantly by age. For ages 85 to 89, mortality rates for males are 42% higher than for females.

- Based on estimated OAS program mortality rates in the year 2001, life expectancies at age 65 for OAS beneficiaries are 16.6 years for males and 20.2 years for females. These are lower than the life expectancies calculated for the 7th OAS Actuarial Report by 0.5 year for males and 0.4 year for females.

- The life expectancies at age 65 for those who receive clawback-reduced OAS benefits because of high income are 19.5 years for males and 22.4 years for females. This group of high-income earners, which represents only 5% of all OAS beneficiaries, experiences significantly higher life expectancies compared to low-income earners who receive GIS benefits. The life expectancies at age 65 for GIS recipients are 15.0 years for males (i.e., 4.5 years lower) and 19.0 years for females (i.e., 3.4 years lower).

- A high level of income is a long-term predictor of lower levels of mortality, and conversely, a low level of income is a long-term predictor of higher levels of mortality. However, the difference in mortality, according to the level of income, decreases with advancing age.

D. Other Findings

- OAS beneficiaries who are immigrants experience lower mortality than beneficiaries who were born in Canada. Consequently, OAS beneficiaries born outside of Canada have greater life expectancies at age 65 than those born in Canada. The differential for males is 1.6 years and for females, it is 1.2 years.

- The greater life expectancies of immigrants as well as their relative better health compared to those born in Canada may be explained by a "healthy immigrant effect"[1] resulting from several factors, including medical and employability screening prior to entry to Canada as well as cultural and lifestyle characteristics.

[1] Chen J., Wilkins R. and Ng E., *Health Expectancy by Immigrant Status, 1986 and 1991*. Health Reports, Winter 1996, Vol. 8, No. 3, Statistics Canada.

E. Conclusion

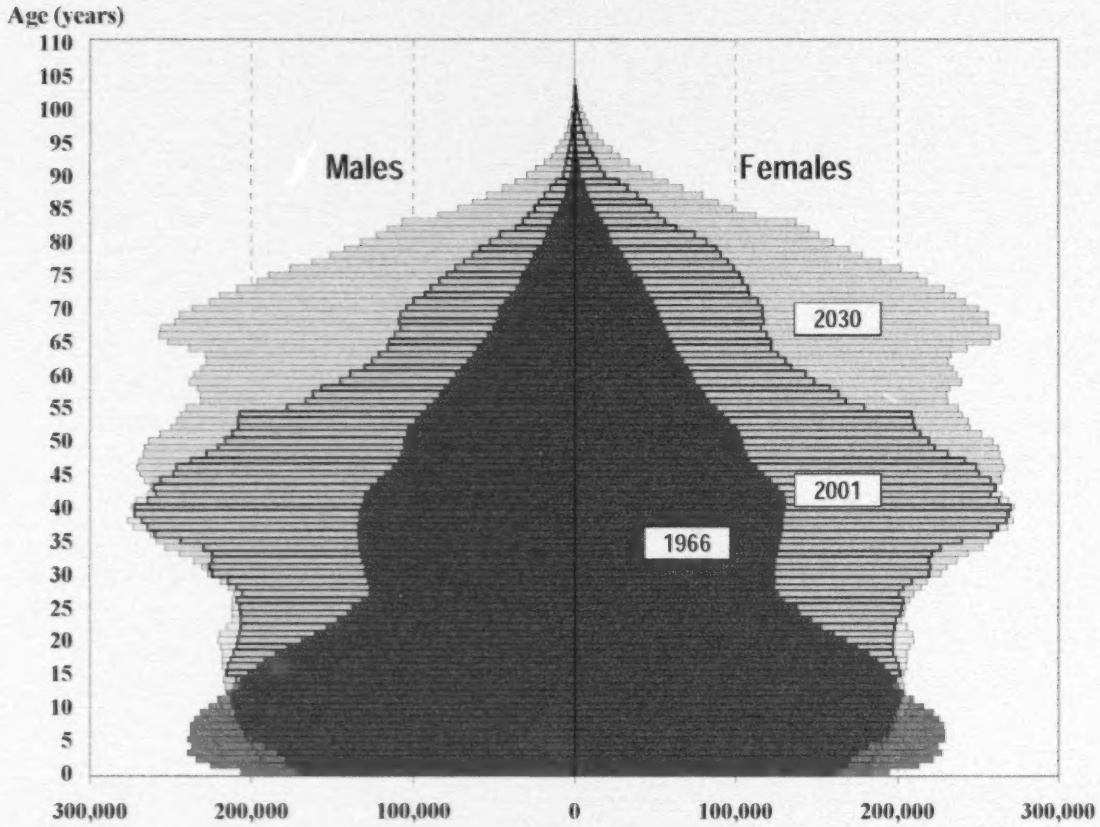
The availability and quality of the administrative OAS beneficiaries database provide sufficient and reliable data upon which this study is based and allow an accurate measurement of the level and trend in mortality experienced by the oldest portion of the Canadian population. The study shows that the level of OAS mortality based on the year 2001 is higher than the projected mortality from the 1995-1997 Life Tables for Canada by about 7% for males and 6% for females.

In general, GIS recipients experience higher mortality and thus lower life expectancies relative to the overall OAS population. In comparison, those who receive clawback-reduced OAS benefits experience lower mortality and higher life expectancies. This may be explained by the association between high levels of income and improved health and quality of life.

II. Canadian Population Trends

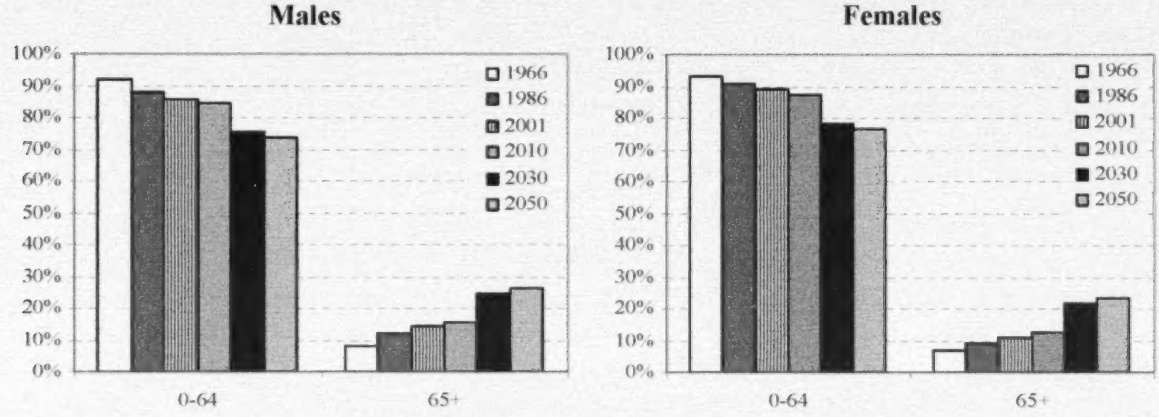
The significant improvement in life expectancy over the last 40 years for those above age 65 is an important cause of the aging of the Canadian population. While most of the increase in life expectancy is a consequence of the reduction in mortality prior to age 65, recent increases in life expectancy have been mainly due to a reduction in mortality at ages 65 and over. The Canadian population has also aged due to a significant drop in the total fertility rate since the late 1950s and the aging of the baby boom generation (those mainly born between the mid-1940s and mid-1960s). Chart 1 shows the importance of the impact of the baby boom generation on the population for years 1966, 2001 and 2030 as the bulk of the age structure moves up into the older ages over time.

Chart 1 Age Structure of the Canadian Population



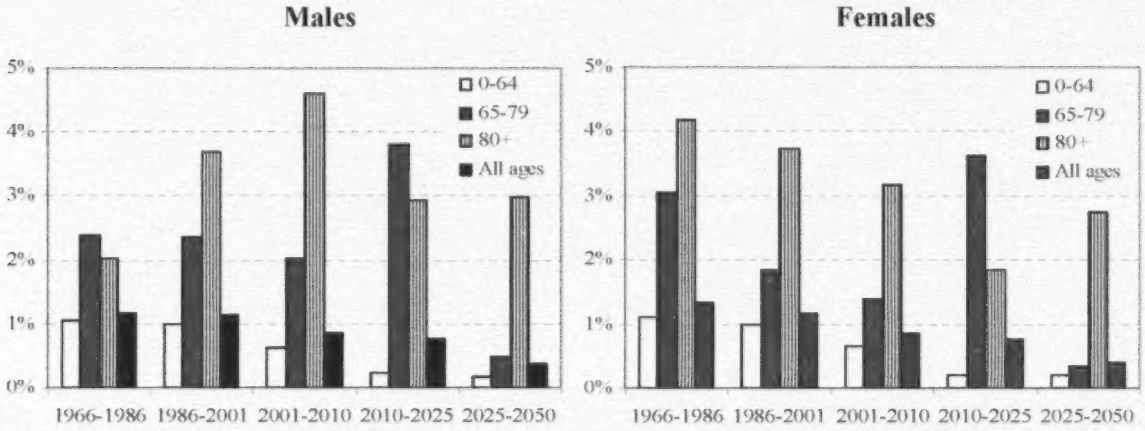
The historical and projected evolution of the proportion of the population aged less than 65 and aged 65 and over is shown in Chart 2. In 2001, 11% of males and 14% of females in the population were aged 65 or older. By 2030, these proportions are expected to grow significantly to 22% and 24% for males and females, respectively.

Chart 2 Distribution of the Canadian Population Below and Above Age 65



The historical and projected annualized growth rate by age group of the Canadian population is shown in Chart 3. While as a whole, the growth of the Canadian population is slowing down, the age group of those aged 80 and over has been one of the fastest growing age groups and this trend is expected to continue. As the growth in the population at the advanced ages is expected to remain strong, an increasing number of people will reach age 100.

Chart 3 Average Annual Growth of the Canadian Population by Age Group



Life expectancy at age 65 provides a good measure of how long social security benefits will be paid for both sexes. As shown in Table 1, life expectancy at age 65 for males was 13.8 years in 1966 and increased to 17.1 years by 2001, representing a growth of 24%. For women, life expectancy at age 65 in 1966 was 16.8 years and increased to 20.6 years over the same period, representing a growth of 23%. For both sexes, life expectancy at age 65 has increased steadily over the period 1966 to 2001. It is interesting to note that the difference between female and male life expectancies at age 65 has narrowed from 4.3 years in 1986 to 3.5 years in 2001. This can be explained by the fact that mortality improvement rates of males aged 65 years and older have been significantly higher than for females of the same age over this period.

Table 1 Evolution of Life Expectancy at Age 65

Year	Males	Females	Female-Male Differential
1966	13.8	16.8	3.0
1971	13.9	17.5	3.7
1976	14.1	18.1	3.9
1981	14.6	18.9	4.2
1986	15.0	19.3	4.3
1991	15.7	19.9	4.2
1996	16.0	19.9	3.9
2001	17.1	20.6	3.5

The evolution of the Canadian population aged 65 and over has a direct impact on the OAS program since it provides a monthly basic OAS pension to all Canadians aged 65 and over who meet the residence and legal status requirements specified in the *Old Age Security Act*. According to the 7th OAS Report, the number of recipients of the basic OAS pension is expected to more than double from 4.0 million in 2003 to 8.9 million in 2030. The number of recipients of the GIS is expected to increase by 66%, growing from 1.5 million in 2003 to 2.4 million in 2030. The percentage increase in GIS recipients is less than that for basic OAS recipients due to the expected decline in the GIS recipient rates over the same period.

The projected population aged 65 and over is continuing to grow and influence the costs of social insurance programs like the OAS. It is thus critical to be able to measure as precisely as possible the mortality experience of this age group. There are many possibilities for the future evolution of mortality at older ages ranging from the theory of squaring of the survival curve (also called "mortality compression") to the theory of steady progress (also called "mortality expansion"). A survival curve at age 65 shows the probability of a 65 year old reaching a given age.

Mortality compression at the older ages occurs if age-specific mortality declines over a widening range of older ages but meets natural limits for very advanced ages, assuming there is a limit to the maximum lifespan. This is consistent with the aging process being both continuous and accompanied by an increasing degree of frailty. Mortality compression is thus also consistent with exponential growth in mortality rates.

In the case of mortality expansion, the age at which natural limits occur could move upward; that is, the maximum age to which one could expect to live would continuously increase. Consequently, all age groups would continue to experience declining mortality. This is consistent with a logistic form of the mortality curve, which has a more gradual growth in mortality at the advanced ages.

This study of the mortality experience of OAS beneficiaries provides a measure of the historical level and trend in mortality experienced by the oldest group of the Canadian population and gives some indication as to which theory for the survival curve at the older ages may best apply.

III. Data and Methodology

A. Data

The main source of data for this study was an administrative seriatim (i.e., by non-identifiable individual record) OAS beneficiary database that was provided by the Department of Human Resources and Social Development Canada (HRSDC), which is the administrator of the OAS program. The OAS database contains information on the amount of regular monthly benefits received by each OAS beneficiary along with the associated payment status (i.e., in pay or terminated) for all OAS beneficiaries at each 31 December for years 1999 to 2003 inclusively. Note that social insurance numbers are masked and it is impossible to identify an individual.

Data from the OAS database were tabulated by year, age at last birthday, sex, place of birth, and levels of income as determined from the type and amount of monthly benefits received. The amount of OAS basic pension paid to persons with high incomes is reduced through a provision of the *Income Tax Act* often referred to as the "clawback provision"[1] while those who are entitled to 100% of the maximum GIS benefit in addition to the OAS basic pension have no or very low income[2]. The mortality experience of OAS beneficiaries is first estimated on an overall basis and then by subgroups that take into account the type of benefit received over the period of the study. The subgroups considered were as follows:

1. **Basic OAS with Clawback**: OAS beneficiaries entitled to a reduced basic OAS pension because of the application of the clawback provision.
2. **Basic OAS without Clawback**: OAS beneficiaries not affected by the application of the clawback provision.
3. **Basic OAS with GIS**: OAS beneficiaries entitled to both a basic OAS pension and income-tested GIS benefit.
4. **Basic OAS without GIS**: OAS beneficiaries not entitled to the GIS benefit.
5. **Basic OAS without Clawback or GIS**: OAS beneficiaries entitled only to a basic OAS pension without clawback or income-tested GIS benefits.

These subgroups comprise different sets of all OAS beneficiaries. Some subgroups include all or part of others. For instance, subgroup 2 is composed of subgroups 3 and 5. Each subgroup, however, was considered important for its own respective characteristics and as such was included in the study.

A second database used for this study was the administrative seriatim Canada Pension Plan (CPP) retirement beneficiary database that was also provided by HRSDC. This database allowed the identification of those OAS beneficiaries who were also in receipt of a CPP retirement benefit. In the absence of an equivalent database for the Québec

[1] The clawback reduction in the OAS basic pension in a given year is based on a beneficiary's net income and a certain threshold in the previous year. For each dollar of net income above the threshold, the OAS basic pension is reduced by 15%. In 2005, the threshold was $60,806 and the pension is completely clawed back at a net income level at or above $98,850.

[2] The level of income used to determine the level of GIS entitlement excludes any benefits received from the OAS program, as well as Employment Insurance premiums, CPP/QPP contributions, a portion of employment income, and various other types of income.

Pension Plan (QPP), it was not possible to identify OAS beneficiaries in receipt of QPP retirement benefits. As a consequence, the study further compares the mortality experience of OAS beneficiaries living in Québec and those living outside of Québec. For OAS beneficiaries residing in Canada excluding Québec, mortality experience was analyzed based on whether or not a CPP retirement benefit was payable.

For all OAS beneficiaries who were reported as being age 110 or older, a validation of date of birth and date of death information was performed by HRSDC, which improved the accuracy of the data for the advanced ages.

For those beneficiaries reported as being between the ages of 100 and 109, a random sample of records was validated by HRSDC. It was found that about 3% of the sample required data corrections. As such, it was estimated that the number of records for this age group requiring corrections would have a minimal impact on the resulting mortality rates.

The CPP retirement beneficiary file was also used as an independent source of information to validate the data consistency of the OAS beneficiary database. For instance, from the two files it was possible to:

- exclude records present in both files that were inconsistent with respect to sex, date of birth, and date of death.

- generate a deemed date of death for records in the OAS database that were missing a date of death but where the payment status information in the OAS database had strongly suggested the occurrence of death based on a statistical analysis of records in both the CPP and OAS files with the same characteristics.

Table 2 shows data validation statistics resulting from the merging of the OAS and CPP databases.

Table 2 Data Validation Statistics

	In Both OAS and CPP Retirement Databases*	OAS Database Only**	Total OAS Database
Number of records prior to the following exclusions:	**3,237,862**	**2,118,992**	**5,356,854**
Exclusions:			
OAS effective year after 2003 (post-study period)	165,893	98,023	263,916
Pending OAS accounts***	574	684	1,258
Inconsistent sex indicator	1,743	n.a.	1,743
Inconsistent OAS entitlement age	108	n.a.	108
Date of birth differs by more than 12 months	152	n.a.	152
Date of death differs by more than 12 months	174	n.a.	174
Deceased status in CPP retirement database within study period but still receiving OAS benefits	23	n.a.	23
Deceased status in CPP retirement database with a deemed date of death prior to study period	236	n.a.	236
Number of records excluded due to pending, inconsistent or error status	**3,010**	**684**	**3,694**
Total number of records excluded	**168,903**	**98,707**	**267,610**
Number of records after exclusions	**3,068,959**	**2,020,285**	**5,089,244**
Proportion of number of records excluded due to pending, inconsistent or error status	**0.10%**	**0.03%**	**0.07%**

* Excludes early retirement CPP beneficiaries under the age of 65 on 31 December 2003.

** Includes OAS beneficiaries aged 65 and over who were either Québec residents (including QPP retirement beneficiaries) or Canada less Québec residents who were not receiving a CPP retirement benefit.

*** Pending OAS accounts were not in pay during the study period.

B. Methodology Overview

This section provides a general overview of the methodology used in the development of the mortality rates of Canadian resident OAS beneficiaries who were aged 65 and older during the period 1 January 1999 to 31 December 2003.

The final mortality rates were based on the year 2001 and were derived using the following four-step process:

1. Production of Annual Crude Mortality Rates

The crude mortality rate for a given age at last birthday in any given calendar year is the probability that a person at that age on 1 January dies by 31 December of that year. Crude mortality rates are usually calculated by simply dividing the relevant number of deaths by the number of exposures, where the number of exposures is the number of lives at the beginning of the year or period and so exposed to the probability of dying over that period. There exist various methods to determine crude mortality rates. For this study, annual crude mortality rates were determined using the Product-Limit Estimator (PLE) method, also known as the Kaplan-Meier Product-Limit Estimator method. Further details of this and other methods are provided in Appendix B. The results of various death and exposure tabulations are given in section IV.A.

2. Production of 2001 Base Year Crude Mortality Rates

The 2001 base year crude mortality rates were derived from annual crude mortality rates over the period 1999 to 2003. The methodology used to derive the year 2001 rates was based on the analysis of four different methods for their soundness and ability to produce mortality rates adjusted for mortality improvements. The methodology is described in detail in Appendix C.

3. Production of 2001 Base Year Graduated Mortality Rates

The 2001 base year crude mortality rates were graduated to reflect a compromise between smoothness and fit. A Whittaker-Henderson Type B graduation method was used to produce the graduated rates up to age 100, which was the highest age showing statistically credible mortality rates.

4. Extension of Mortality Rates to Age 120

Two methods were used to extend the graduated rates beyond age 100.

The first method was to extend a least squares linear regression of the function $\ln(q_x/q_{x-1})$ on age, where q_x was the 2001 base year graduated mortality rates for males and females at age x. The function was almost linear between the ages 90 and 100 for each sex. Under this method, which assumes a gradual growth in mortality rates at the advanced ages, the ultimate mortality rates reached at age 120 were about 0.62 for males and 0.54 for females. In comparison, the 2001 benchmark mortality rates were about 0.82 and 0.70 at age 119 for males and females, respectively. The mortality rates for the different subgroups studied were set to converge to those of the overall population of OAS beneficiaries at advanced ages.

The second method of extension of mortality rates used the same mortality rates as derived from the first method up until age 110. From age 110, mortality rates were then projected using an exponential growth model to eventually reach a mortality rate of 1 by age 120.

The mortality rates obtained from the first method were preferred for this study, as they better reflected the experience and trend in mortality rates at the advanced ages for both sexes.

IV. Results

A. Overall OAS Program Mortality

As the OAS program provides pensions to almost all Canadians aged 65 and over, the availability of an administrative OAS database allows us to measure more accurately the level and trend in mortality experienced by the oldest portion of the Canadian population.

1. Deaths

The basic element in the estimation of the OAS program mortality rates is to count the number of deaths by calendar year, age and sex. As only the year and month of birth were available from the OAS database, the day of birth for each OAS beneficiary was assumed to be in the middle of that month. This in turn divided the year into 24 subintervals, each beginning either on the 1st or middle of the month. Similarly, as only the year and month of death were available, the day of death was assumed to be in the middle of that month.

Special adjustments were made in the cases where both the months of birth and death were the same. For these cases, a uniform distribution of births and deaths was assumed so that, on average, half the deaths occur before the date of death and the other half occur after. This results in about half the number of deaths occurring at the unadjusted age at death and the other half at an age one year younger.

Table 3 presents the number of deaths from the overall OAS program at ages 65 and over by age group and sex. Of the 868,086 observed deaths from the OAS database, there were 7,824 (83% being females) alleged to have died as centenarians, and among those, 29 (97% being females) died as supercentenarians (aged 110 or older). Table 23 and Table 24 in Appendix A show detailed statistics on the number of male and female deaths by individual age for various subgroups of beneficiaries.

Table 3 OAS Beneficiary Deaths (1999-2003)

Age Group	OAS Program		
	Males	Females	Both Sexes
65-69	53,665	33,482	87,147
70-74	75,473	51,001	126,474
75-79	90,793	74,684	165,477
80-84	86,183	90,856	177,038
85-89	66,868	97,019	163,886
90-94	32,744	69,564	102,308
95-99	9,144	28,790	37,934
100-104	1,225	5,974	7,199
105-109	84	512	596
110+	1	28	29
Total	416,179	451,907	868,086

Table 4 shows a comparison by age group and sex of the number of OAS beneficiary deaths to the number of deaths as reported by Statistics Canada (official vital statistics) over the period 1999 to 2003. For ages 65 to 69, the lower number of OAS deaths compared to that of the vital statistics may be explained by recipient rates for the OAS benefit being less than 100%. This may be explained by the fact that a portion of the population has still not applied for the OAS benefit by age 69 as they are not yet eligible or have elected not to receive OAS benefits. For ages 70 and above, the number of deaths from vital statistics was lower than that of OAS beneficiaries.

Table 4 OAS Beneficiary Versus Vital Statistics Deaths (1999-2003)

	Males			Females		
Age Group	OAS	Vital Statistics(*)	Ratio OAS to Vital Statistics	OAS	Vital Statistics(*)	Ratio OAS to Vital Statistics
65-69	53,665	54,191	99%	33,482	34,003	98%
70-74	75,473	74,822	101%	51,001	50,822	100%
75-79	90,793	89,767	101%	74,684	74,421	100%
80-84	86,183	85,144	101%	90,856	90,105	101%
85-89	66,868	66,292	101%	97,019	96,310	101%
90+	43,198	43,113	100%	104,868	104,163	101%
65+	416,179	413,329	101%	451,907	449,824	100%

(*) The number of deaths for the period 1999 to 2002 is from official vital statistics from Statistics Canada, while the number of deaths for 2003 is derived from post-Census estimates of Statistics Canada.

2. Exposures

Exposures by calendar year, age and sex were derived using a seriatim approach. Exposures are interpreted as the number of life-years that were exposed to risk of death during the period examined.

The exposures were determined by an exact age method whereby, for each person, exposure was measured from the normal age at commencement of OAS benefits (65.04 years) to the time of death. The exposures were then tabulated by age and sex. The fractional years were determined by attained age at each birthday and at the end of each year of the study. Each half-month was given the same weight of one twenty-fourth of a year.

Exposures by age group and sex are shown in Table 5. As females live longer than males on average, the exposures for females are distributed more to the advanced ages. Tables 25, 26 and 27 in Appendix A present various detailed statistics related to exposures.

Table 5 OAS Beneficiary Exposures (1999-2003)

	Exposures		Distribution	
Age Group	Males	Females	Males	Females
65-69	2,613,513	2,808,490	32.2%	25.9%
70-74	2,262,297	2,652,654	27.9%	24.5%
75-79	1,663,584	2,309,706	20.5%	21.3%
80-84	963,117	1,615,836	11.9%	14.9%
85-89	451,368	949,856	5.6%	8.8%
90-94	140,566	393,925	1.7%	3.6%
95-99	25,720	100,691	0.3%	0.9%
100-104	2,567	14,155	0.0%	0.1%
105-109	135	925	0.0%	0.0%
110+	5	44	0.0%	0.0%
65+	8,122,873	10,846,282	100.0%	100.0%

The number of OAS beneficiaries as at December 31 of each of the years in the study period is shown in Table 6. The OAS program provides a payment in the month of death, which is reflected in the number of beneficiaries shown. Table 28 in Appendix A presents the number of OAS beneficiaries by individual age in pay as at December 31 over the study period. As at 31 December 2003 and verified by HRSDC, the oldest male beneficiary was age 110 and the oldest female beneficiary was age 112.

Table 6 Number of OAS Beneficiaries in Pay (1999-2003)

As at 31st December	1999		2000		2001		2002		2003	
Age Group	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
65-69	520,542	560,886	519,242	560,013	520,480	560,246	521,124	561,636	523,424	564,145
70-74	437,767	524,363	448,730	528,030	458,017	532,029	466,366	536,506	470,144	535,826
75-79	322,531	457,425	329,781	462,626	336,519	465,299	344,929	467,377	354,644	470,623
80-84	176,021	299,057	186,342	313,856	198,393	330,554	210,437	347,570	221,112	361,595
85-89	86,621	183,065	90,224	189,432	93,155	194,979	95,213	198,261	97,775	202,531
90-94	26,459	74,483	27,808	77,888	28,988	80,823	30,740	85,090	32,675	89,444
95-99	4,968	19,177	5,056	19,959	5,267	20,841	5,602	21,870	5,967	23,006
100-104	530	2,761	514	2,868	513	2,910	531	3,016	566	3,208
105-109	18	164	22	166	26	190	31	207	27	222
110+	1	14	1	11	1	8	1	7	1	6
65+	1,575,458	2,121,395	1,607,720	2,154,849	1,641,359	2,187,879	1,674,974	2,221,540	1,706,335	2,250,606

3. Mortality Rates

a) 2001 Base Year Crude Mortality Rates

The resulting 2001 base year crude mortality rates by age and sex are presented in Table 7. The ratio of male to female rates is an indicator of the average shorter lifetimes of males compared to females. However, although males experience a higher level of mortality than females, the relative gap between the two sexes narrows as mortality converges with advancing ages as can be seen by the falling male/female mortality ratio.

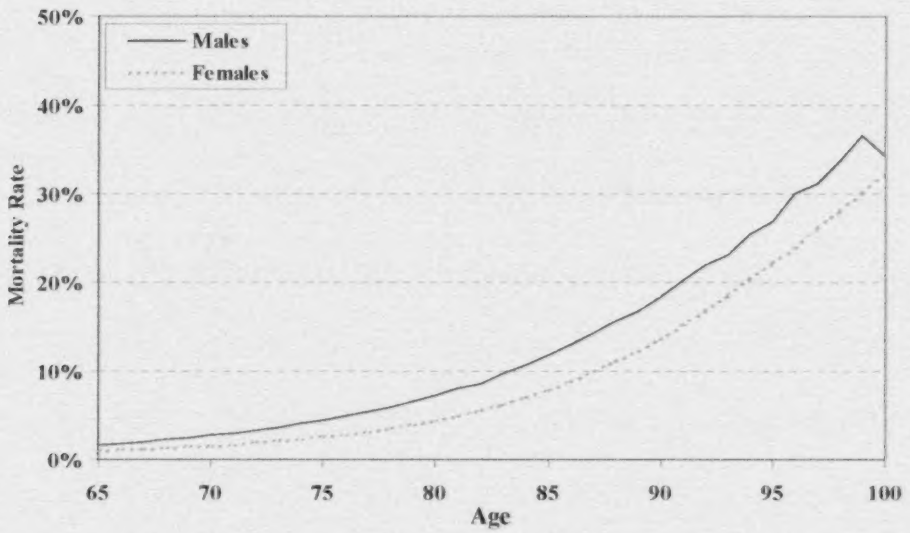
Table 7 OAS Beneficiary Crude Mortality Rates (2001)

Age Group	Males	Females	Ratio Males to Females
65-69	0.0203	0.0118	1.71
70-74	0.0328	0.0190	1.72
75-79	0.0532	0.0318	1.67
80-84	0.0858	0.0548	1.57
85-89	0.1379	0.0971	1.42
90-94	0.2082	0.1620	1.28
95-99	0.2990	0.2488	1.20
100*	0.3427	0.3252	1.05

* Age 100 was the highest age with statistically credible crude mortality rates.

The progression of the 2001 base year crude mortality rates by age and for each sex is displayed in Chart 4. Males experience a higher level of mortality than females except at the very advanced ages.

Chart 4 OAS Beneficiary Crude Mortality Rates (2001)



b) 2001 Base Year Graduated Mortality Rates

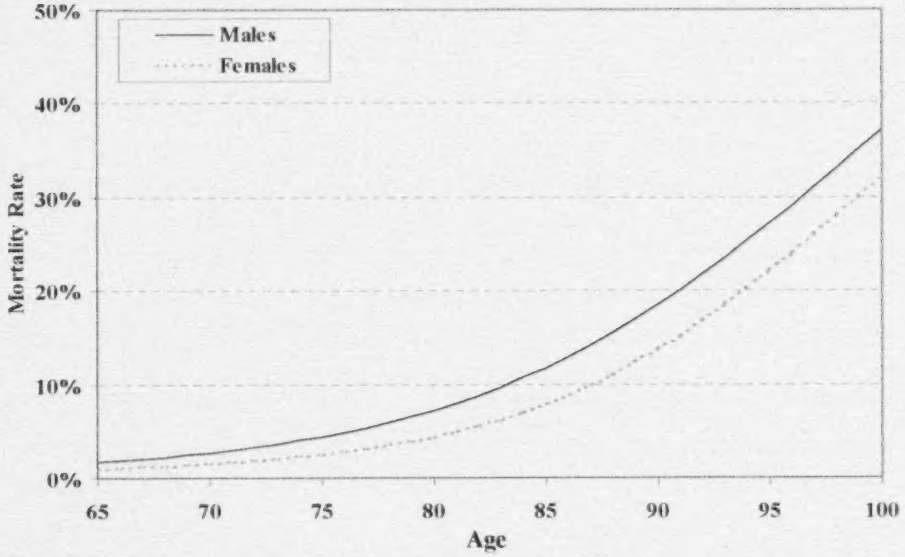
The graduated mortality rates by age and sex and the corresponding ratio of male to female rates are presented in Table 8. As noted for the crude mortality rates, males experience a higher level of mortality than females, but the relative gap between the sexes decreases with advancing ages as can be seen by the falling male/female graduated mortality ratio.

The crude mortality rates were graduated up to age 100, which was the highest age with statistically credible rates. The graduated rates from age 100 were then extended to age 120, which was considered to be the maximum attainable lifespan. The projection of the rates to age 120 is discussed further in the following subsection. Chart 5 below shows the graduated mortality rates to age 100 for each sex.

Table 8 OAS Beneficiary Graduated Mortality Rates (2001)

Age Group	Males	Females	Ratio Males to Females
65-69	0.0203	0.0118	1.72
70-74	0.0328	0.0190	1.73
75-79	0.0532	0.0318	1.67
80-84	0.0858	0.0549	1.56
85-89	0.1377	0.0970	1.42
90-94	0.2086	0.1623	1.29
95-99	0.2957	0.2482	1.19
100	0.3711	0.3211	1.16

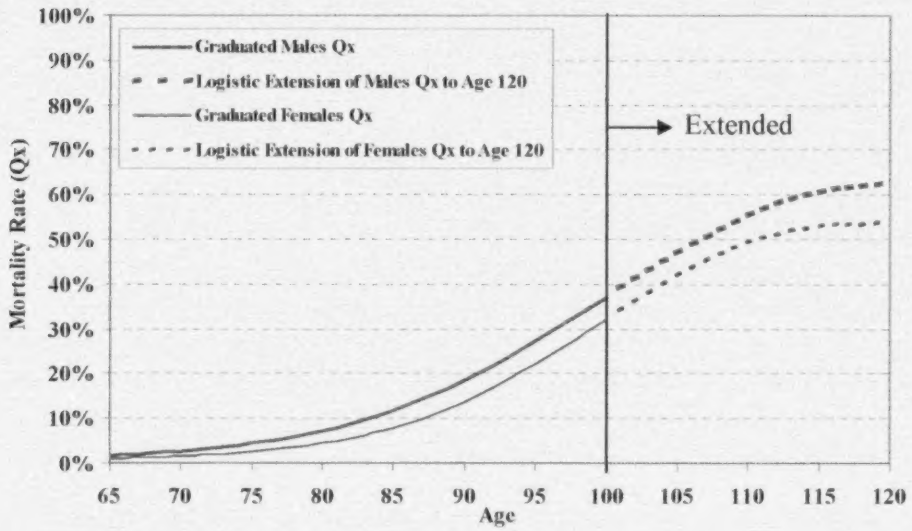
Chart 5 OAS Beneficiary Graduated Mortality Rates (2001)



c) Extension of Graduated Mortality Rates to Age 120

The graduated mortality rates were extended to age 120 using a logistic[1] function since it reflected rising mortality at diminishing rates as seen at the advanced ages. An exponential function was also considered but not used, as explained further in Appendix D. The graduated and extended rates for both sexes are shown below in Chart 6.

Chart 6 OAS Beneficiary Mortality Rates with Extensions to Age 120 (2001)



[1] A logistic curve is an S-shaped curve which models the growth of some population over time. It is characterized by low initial growth, followed by a period of rapid or exponential growth, and then ending with a gradual slowing down to an equilibrium level as the population matures.

B. Mortality Comparisons

In this section, mortality rates of different groups are compared by way of ratios of the rates by age and sex. A comparison is first made between the overall mortality of OAS beneficiaries and a benchmark mortality table. A comparison is then made for OAS beneficiaries between those born in Canada and immigrants. A third comparison is made between various subgroups of the OAS beneficiaries by type of benefits received. Lastly, comparisons are made for the population of Canada less Québec with respect to the overall mortality of the beneficiaries and between those in receipt of CPP retirement benefits and those not in receipt of the benefits.

1. Comparison with Benchmark Mortality

Since OAS program beneficiaries represent a large portion of the older Canadian population, the base year 2001 OAS mortality rates were compared to a benchmark mortality table for Canada for the year 2001. The benchmark mortality table was derived from the Life Tables for Canada for years 1995 to 1997, projected to the year 2001 based on mortality improvement rates from 1996. This benchmark corresponds to the starting point of the mortality projections in the 7th OAS Report.

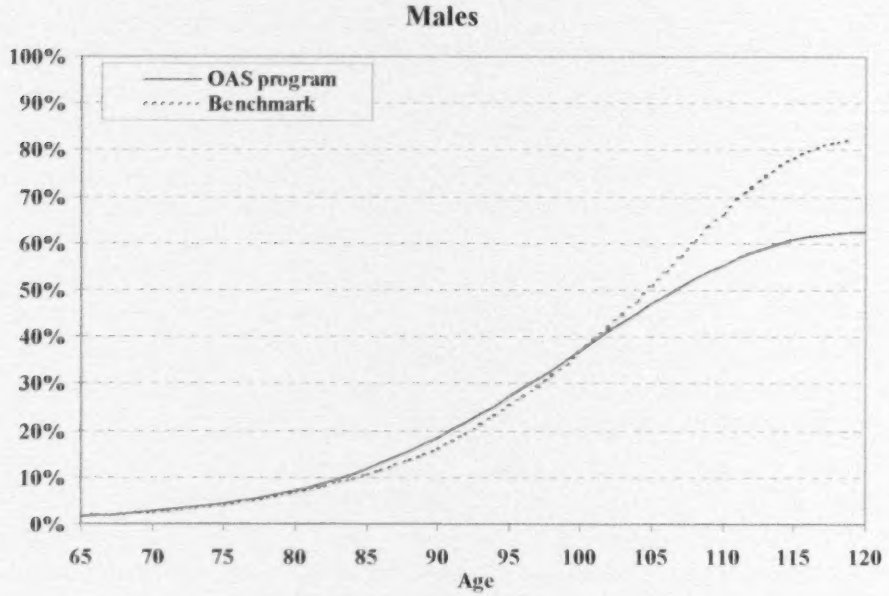
Male and female OAS beneficiaries experienced higher mortality in relation to the benchmark mortality, as shown in Table 9. The ratio of OAS mortality rates to benchmark rates is generally higher for males than for females. The highest mortality ratios occur for males in the age groups between 85 and 94. Mortality rates and other life table statistics for OAS beneficiaries are provided in Table 29 of Appendix A.

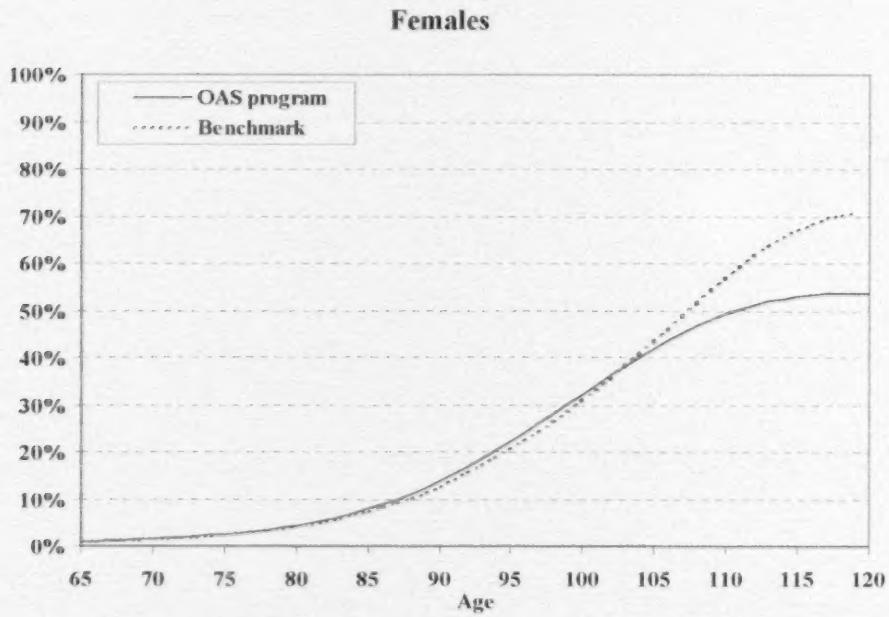
Table 9 OAS Beneficiary Versus Benchmark Mortality Rates (2001)

Age Group	Males			Females		
	OAS	Benchmark	Ratio OAS to Benchmark	OAS	Benchmark	Ratio OAS to Benchmark
65-69	0.0203	0.0197	1.03	0.0118	0.0113	1.04
70-74	0.0328	0.0314	1.04	0.0190	0.0181	1.05
75-79	0.0532	0.0499	1.07	0.0318	0.0306	1.04
80-84	0.0858	0.0793	1.08	0.0549	0.0526	1.04
85-89	0.1377	0.1231	1.12	0.0970	0.0905	1.07
90-94	0.2086	0.1858	1.12	0.1623	0.1501	1.08
95-99	0.2957	0.2799	1.06	0.2482	0.2324	1.07
100+	0.3977	0.4045	0.98	0.3500	0.3457	1.01
65+	0.0491	0.0458	1.07	0.0398	0.0377	1.06

The graphs of OAS and benchmark mortality rates for year 2001 are shown below in Chart 7. OAS mortality rates for females are relatively closer to their respective benchmark than for males. For both sexes, however, the OAS mortality curves are flatter than the benchmarks after age 80, and the difference is pronounced after age 100 when OAS mortality falls below the benchmarks.

Chart 7 OAS Beneficiary Versus Benchmark Mortality Rates (2001)





2. Comparison Between Those Born in Canada and Immigrants

Immigration to Canada has historically been volatile. However, historical levels have been relatively high compared to the general population. Moreover, as the total fertility rate has fallen significantly since the late 1950s to below replacement level, immigration has composed an increasing portion of the growth of the Canadian population. The number of life-years of exposure by place of birth is shown in Table 10. The proportion of those born outside Canada increases with age group.

Table 10 OAS Beneficiary Exposures by Place of Birth (1999-2003)

	Males				Females			
Age Group	Born in Canada	Born Outside of Canada	OAS Beneficiaries	Proportion Born Outside of Canada	Born in Canada	Born Outside of Canada	OAS Beneficiaries	Proportion Born Outside of Canada
65-69	1,883,166	730,347	2,613,513	28%	2,089,067	719,423	2,808,490	26%
70-74	1,613,425	648,872	2,262,297	29%	1,952,504	700,149	2,652,653	26%
75-79	1,176,255	487,330	1,663,585	29%	1,668,326	641,381	2,309,707	28%
80-84	714,208	248,909	963,117	26%	1,239,604	376,231	1,615,835	23%
85-89	326,751	124,617	451,368	28%	715,128	234,729	949,857	25%
90-94	71,019	69,547	140,566	49%	207,441	186,484	393,925	47%
95-99	8,965	16,755	25,720	65%	37,396	63,295	100,691	63%
100+	871	1,836	2,707	68%	5,373	9,751	15,124	64%
65+	5,794,660	2,328,213	8,122,873	29%	7,914,840	2,931,442	10,846,282	27%

As presented in Table 11 and illustrated in Chart 8, immigrants experience lower mortality than those born in Canada. As such, immigrants have contributed to increasing life expectancies in Canada. The greater life expectancies of immigrants as well as their relative better health compared to those born in Canada may be explained by a "healthy immigrant effect" as referred to by Chen, Wilkins and Ng[1]. They describe this effect as resulting from several factors. First, people in poor health are less likely to migrate to another country. In addition, all potential immigrants to Canada are subject to medical screening. Moreover, immigrants to Canada are partially selected on the basis of employability, which would imply a certain status of health. As new immigrants tend to be healthy, they could experience greater life expectancies than those who had immigrated years earlier. Lastly, cultural and lifestyle characteristics of immigrants may also contribute to their relative better health and increased longevities. Table 31 in Appendix A provides the mortality ratios of OAS beneficiaries by individual age and place of birth.

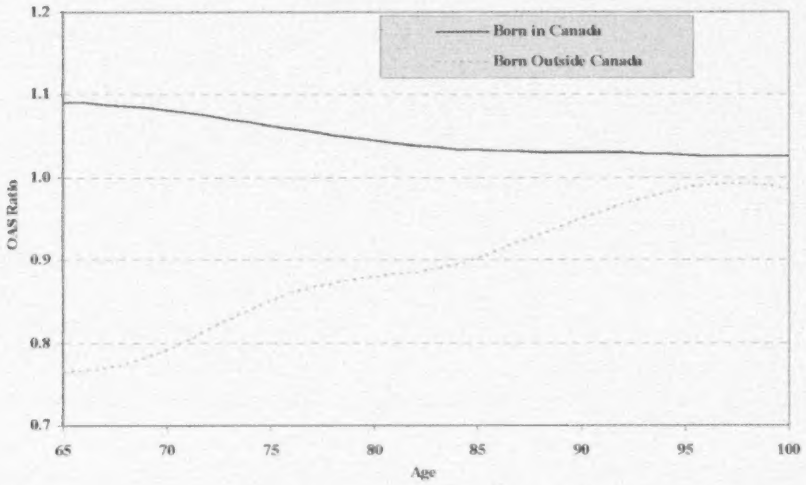
[1] Chen J., Wilkins R. and Ng E., *Health Expectancy by Immigrant Status, 1986 and 1991*. Health Reports, Winter 1996, Vol. 8, No. 3, Statistics Canada.

Table 11 OAS Beneficiary Mortality Rates by Place of Birth (2001)

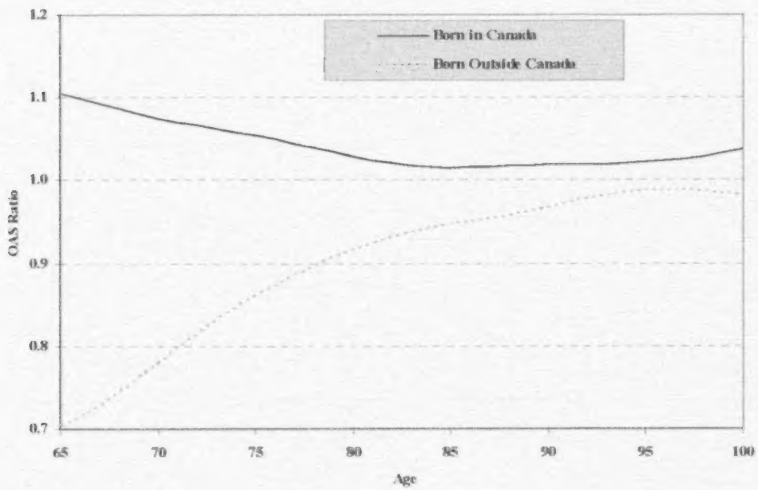
	Males					Females				
Age Group	Born in Canada	Ratio Born in Canada to Overall OAS	Born Outside of Canada	Ratio Born Outside of Canada to Overall OAS	Overall OAS	Born in Canada	Ratio Born in Canada to Overall OAS	Born Outside of Canada	Ratio Born Outside of Canada to Overall OAS	Overall OAS
65-69	0.0221	1.09	0.0157	0.77	0.0203	0.0129	1.09	0.0087	0.73	0.0118
70-74	0.0352	1.07	0.0269	0.82	0.0328	0.0202	1.06	0.0156	0.82	0.0190
75-79	0.0561	1.06	0.0460	0.86	0.0532	0.0332	1.04	0.0281	0.88	0.0318
80-84	0.0894	1.04	0.0754	0.88	0.0858	0.0562	1.02	0.0505	0.92	0.0549
85-89	0.1412	1.03	0.1287	0.93	0.1377	0.0980	1.01	0.0944	0.97	0.0970
90-94	0.2112	1.01	0.2046	0.98	0.2086	0.1618	1.00	0.1623	1.00	0.1623
95-99	0.3025	1.02	0.2929	0.99	0.2957	0.2538	1.02	0.2453	0.99	0.2482
100+	0.3995	1.00	0.3956	0.99	0.3977	0.3604	1.03	0.3446	0.98	0.3500

Chart 8 OAS Beneficiary Mortality Ratios by Place of Birth (2001)

Males



Females



3. Comparison by Type of Benefit

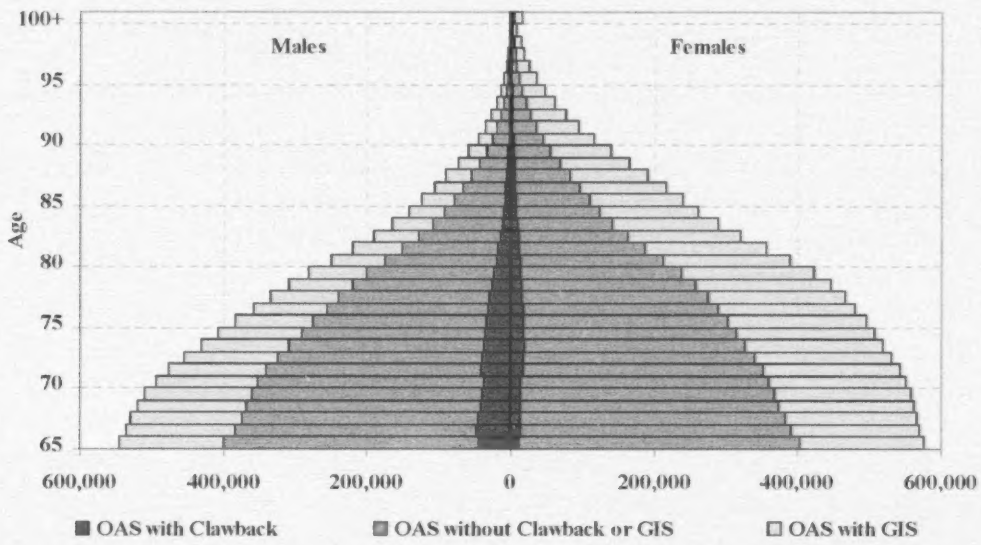
a) OAS, GIS, and the Clawback

The age and sex structure of the amount of exposures by type of OAS benefit received over the period from 1999 to 2003 is displayed in Chart 9. The total exposures for females exceed that for males, and this is especially evident at the older ages. This difference is indicative of life expectancies for females being greater than for males.

Consistent with the fact that males generally have higher levels of income than females, the proportion of life-years during which males received clawback-reduced OAS benefits was higher than the corresponding proportion for females. For instance, the clawback was applied to 8% of exposures for males compared to 2% for females at age 65. Likewise, the proportion of life-years during which females received GIS benefits was higher than the corresponding proportion for males. The GIS was payable for 30% of exposures for females compared to 27% for males at age 65.

A higher proportion of the exposures was subject to the basic OAS pension only at age 65 compared to other ages. This may be indicative of the approximate one-year lag that exists in the OAS program to recognize those who would be affected by the clawback or entitled to the GIS.

Chart 9 Structure of OAS Beneficiary Exposures by Type of Benefit (1999-2003)



Note that the exposure at age 65 in Chart 9 has been adjusted upward to take into account that OAS entitlement occurs at age 65.04 on an exact age basis. As such, the exposure at age 65 is missing $1/24^{th}$ of a year relative to the other ages.

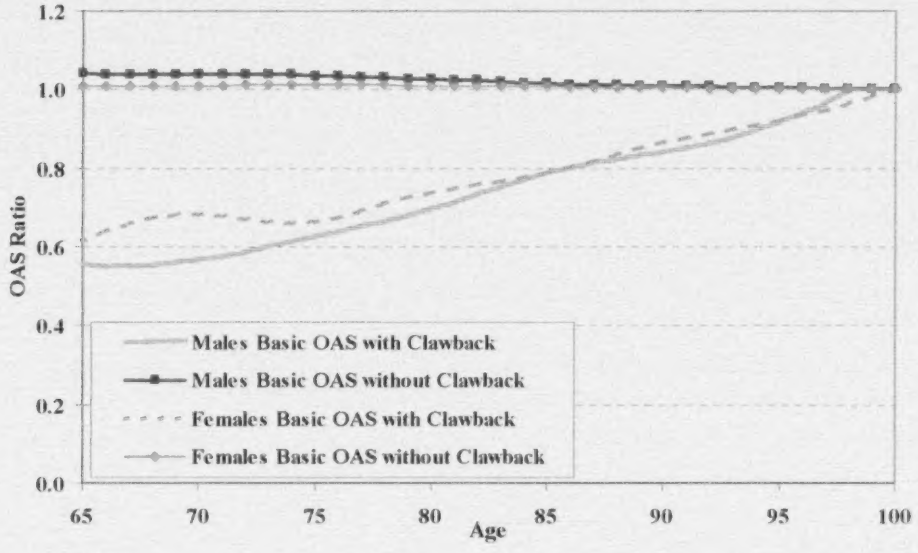
b) OAS with and without the Clawback

A comparison of the mortality rates between those who receive the basic OAS pension subject to the clawback, those not subject to the clawback, and all OAS beneficiaries is shown in Table 12 and Chart 10. Although they represent a small percentage of OAS beneficiaries, those who had their OAS benefits reduced by the clawback because of high income experienced significantly lower levels of mortality. Males experienced a wider range in mortality ratios than females. For example, males with clawback-reduced pensions experienced a mortality ratio of 0.55 compared to 0.66 for females for the age group 65 to 69. The corresponding mortality ratios for those not affected by the clawback provision are 1.04 for males and 1.01 for females. For both sexes, the mortality ratios converge to 1.0 as age increases. Table 32 in Appendix A provides mortality ratios by individual age and type of benefit.

Table 12 Mortality Rates of OAS Beneficiaries by Application of the Clawback (2001)

	Males					Females				
Age Group	Basic OAS with Clawback	Ratio OAS with Clawback to Overall OAS	Basic OAS without Clawback	Ratio OAS without Clawback to Overall OAS	Overall OAS	Basic OAS with Clawback	Ratio OAS with Clawback to Overall OAS	Basic OAS without Clawback	Ratio OAS without Clawback to Overall OAS	Overall OAS
65-69	0.0113	0.55	0.0211	1.04	0.0203	0.0078	0.66	0.0119	1.01	0.0118
70-74	0.0196	0.60	0.0340	1.04	0.0328	0.0129	0.68	0.0192	1.01	0.0190
75-79	0.0348	0.65	0.0549	1.03	0.0532	0.0220	0.69	0.0321	1.01	0.0318
80-84	0.0625	0.73	0.0878	1.02	0.0858	0.0414	0.75	0.0553	1.01	0.0549
85-89	0.1110	0.81	0.1395	1.01	0.1377	0.0788	0.81	0.0976	1.01	0.0970
90-94	0.1794	0.86	0.2102	1.01	0.2086	0.1432	0.88	0.1628	1.00	0.1623
95-99	0.2781	0.94	0.2967	1.00	0.2957	0.2319	0.93	0.2486	1.00	0.2482
100+	0.3936	0.99	0.3970	1.00	0.3977	0.3470	0.99	0.3501	1.00	0.3500

Chart 10 Mortality Ratios of OAS Beneficiaries by Application of the Clawback (2001)



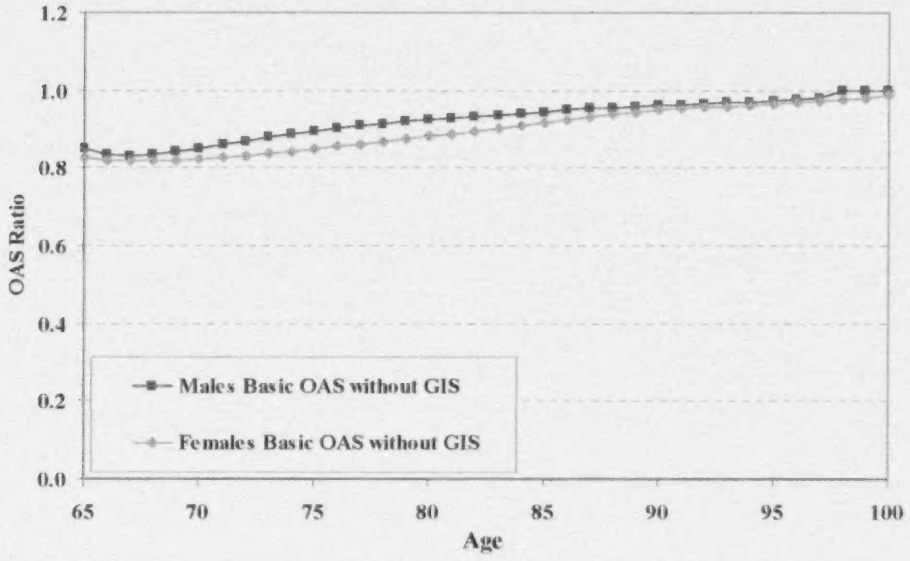
c) OAS without the GIS

A comparison of the mortality rates between those who receive the basic OAS pension with no GIS and all OAS beneficiaries is shown in Table 13 and Chart 11. Those beneficiaries who do not receive the GIS experience lower mortality compared to all OAS beneficiaries collectively. However, the subgroup rates approach the overall level as age increases, as seen by the increasing mortality ratios for both males and females.

Table 13 Mortality Rates of OAS Beneficiaries Not Receiving the GIS (2001)

	Males			Females		
Age Group	Basic OAS without GIS	Overall OAS	Ratio OAS without GIS to Overall OAS	Basic OAS without GIS	Overall OAS	Ratio OAS without GIS to Overall OAS
65-69	0.0170	0.0203	0.84	0.0097	0.0118	0.82
70-74	0.0286	0.0328	0.87	0.0158	0.0190	0.83
75-79	0.0483	0.0532	0.91	0.0273	0.0318	0.86
80-84	0.0795	0.0858	0.93	0.0487	0.0549	0.89
85-89	0.1304	0.1377	0.95	0.0897	0.0970	0.92
90-94	0.2001	0.2086	0.96	0.1541	0.1623	0.95
95-99	0.2886	0.2957	0.98	0.2398	0.2482	0.97
100+	0.3954	0.3977	0.99	0.3463	0.3500	0.99

Chart 11 Mortality Ratios of OAS Beneficiaries Not Receiving the GIS (2001)



d) OAS with the GIS

The proportion of those OAS beneficiaries who were receiving the GIS benefit at the time of death generally increases with age as shown in Table 14. This is explained by the general trend that as older ages are reached net income tends to decrease, which leads to an increased likelihood of receiving the GIS.

The proportion of male OAS beneficiaries who were receiving the GIS benefit at the time of death increases overall from 40% for those in the age group 65 to 69 to 64% for those aged 100 and over. For females, the corresponding proportion increases from 45% to 74% over the same age range.

Table 14 OAS and GIS Beneficiary Deaths (1999-2003)

Age Group	Males			Females		
	Basic OAS with GIS	OAS Beneficiaries	Proportion OAS with GIS	Basic OAS with GIS	OAS Beneficiaries	Proportion OAS with GIS
65-69	21,677	53,665	40%	14,917	33,482	45%
70-74	28,606	75,473	38%	23,959	51,001	47%
75-79	31,993	90,793	35%	37,012	74,684	50%
80-84	32,213	86,183	37%	49,697	90,856	55%
85-89	28,045	66,868	42%	58,364	97,019	60%
90-94	16,209	32,744	50%	45,344	69,564	65%
95-99	5,188	9,144	57%	20,103	28,790	70%
100+	843	1,310	64%	4,849	6,514	74%
65+	164,773	416,179	40%	254,243	451,907	56%

The number of life-years of exposure for those receiving the GIS benefit in comparison to the overall amount of exposure for OAS beneficiaries is shown in Table 15. The proportion of exposures for female GIS recipients is significantly greater than that for males at all age groups, especially at and above age 70. This is due to women receiving less income than men and can be linked to the historically lower participation of women in the workforce. However, labour force participation rates for females have significantly increased recently and it is projected that the male-female participation gap will further narrow in the long term.

For males, the proportion of exposures for GIS recipients remains steady at 29% for age groups between 65 and 79 and then increases to 64% for those aged 100 and over. For females, the corresponding proportion increases through all age groups, from 32% for those aged 65 to 69 to 73% for those aged 100 and over.

For both sexes in the age group 65 to 69, the proportion of exposures for GIS recipients is significantly less than the proportion of deaths which reflects the higher level of mortality of GIS recipients for that age group. The difference in the proportions declines as age increases. For those aged 100 and older, exposure and death proportions are close to equal.

Table 15 OAS and GIS Beneficiary Exposures (1999-2003)

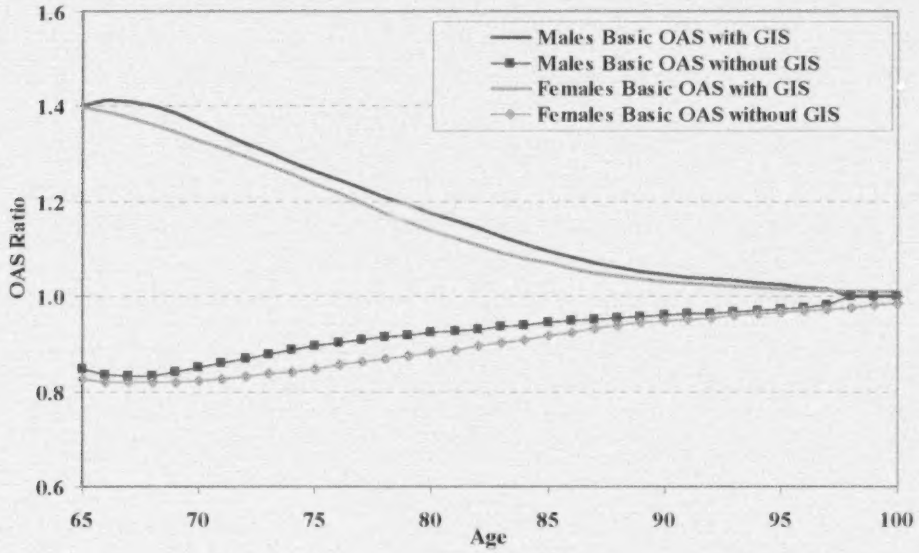
Age Group	Males			Females		
	Basic OAS with GIS	Overall OAS	Proportion OAS with GIS	Basic OAS with GIS	Overall OAS	Proportion OAS with GIS
65-69	747,432	2,613,513	29%	906,393	2,808,490	32%
70-74	645,554	2,262,297	29%	959,406	2,652,654	36%
75-79	474,465	1,663,584	29%	948,162	2,309,706	41%
80-84	308,856	963,117	32%	788,235	1,615,836	49%
85-89	174,116	451,368	39%	538,508	949,856	57%
90-94	65,935	140,566	47%	248,743	393,925	63%
95-99	14,235	25,720	55%	69,253	100,691	69%
100+	1,743	2,707	64%	11,116	15,124	73%
65+	2,432,335	8,122,873	30%	4,469,816	10,846,282	41%

The mortality rates and mortality ratios of those who receive the GIS benefit are shown in Table 16 and Chart 12. For each sex, mortality ratios decrease and converge to the overall OAS program mortality at the advanced ages. Mortality ratios for those not in receipt of the GIS are also shown in Chart 12 for comparison.

Table 16 OAS and GIS Beneficiary Mortality Rates (2001)

Age Group	Males			Females		
	Basic OAS with GIS	Overall OAS	Ratio OAS with GIS to Overall OAS	Basic OAS with GIS	Overall OAS	Ratio OAS with GIS to Overall OAS
65-69	0.0286	0.0203	1.41	0.0163	0.0118	1.38
70-74	0.0433	0.0328	1.32	0.0247	0.0190	1.30
75-79	0.0653	0.0532	1.23	0.0381	0.0318	1.20
80-84	0.0990	0.0858	1.15	0.0613	0.0549	1.12
85-89	0.1489	0.1377	1.08	0.1026	0.0970	1.06
90-94	0.2180	0.2086	1.05	0.1668	0.1623	1.03
95-99	0.3016	0.2957	1.02	0.2520	0.2482	1.02
100+	0.3977	0.3977	1.00	0.3533	0.3500	1.01

Chart 12 Mortality Ratios of OAS Beneficiaries by Receipt of the GIS (2001)



4. Others

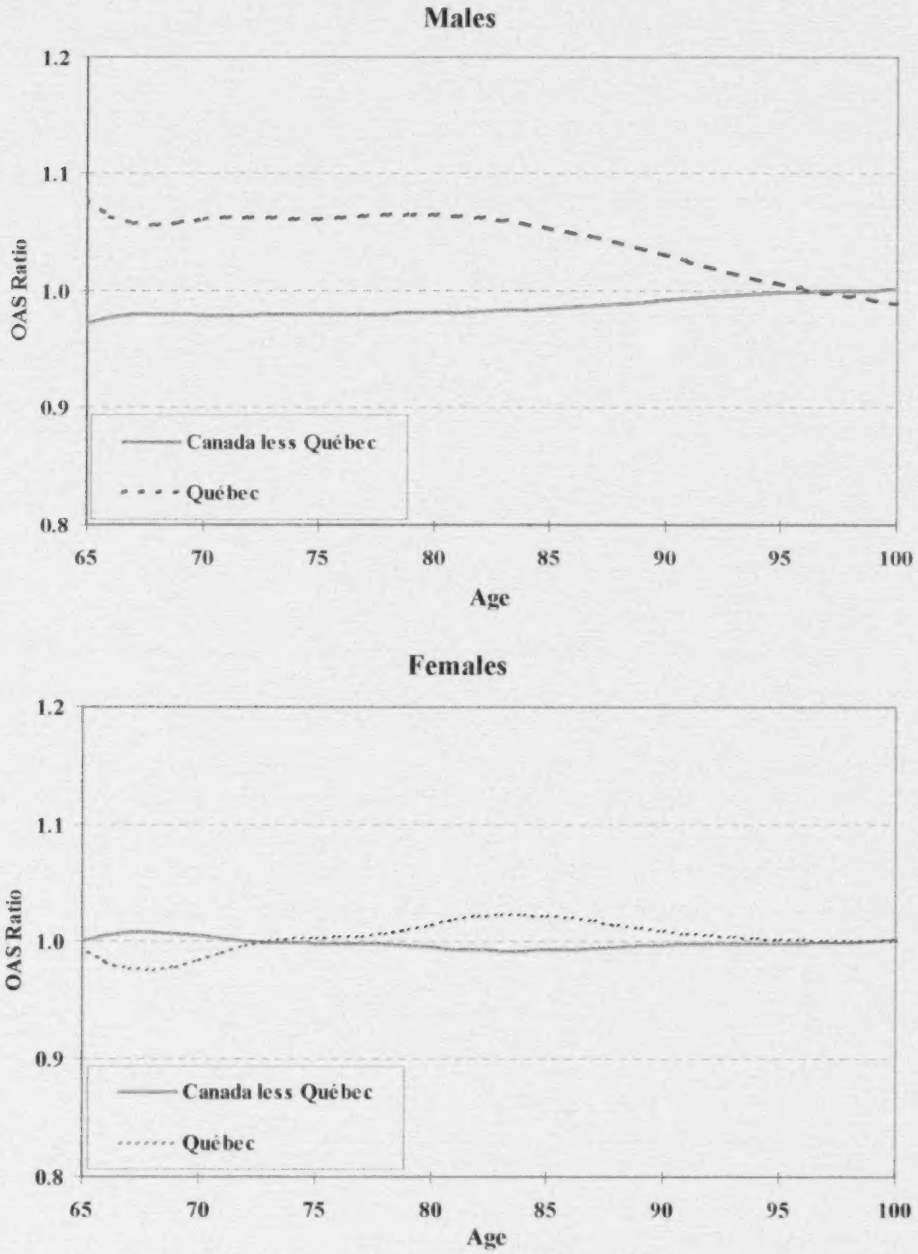
a) Canada less Québec and Québec Residents

Male OAS beneficiaries residing in the region of Canada less Québec experience lower mortality than OAS male beneficiaries collectively, while those males residing in Québec experience higher mortality. In comparison, female OAS beneficiaries residing in Canada less Québec and in Québec experience very similar mortality to all female OAS beneficiaries. These results are shown in Table 17 and Chart 13.

Table 17 OAS Beneficiary Mortality Rates by Place of Residence (2001)

	Males				Females			
Age Group	Canada less Québec	Ratio Canada less Québec to Overall OAS	Québec	Ratio Québec to Overall OAS	Canada less Québec	Ratio Canada less Québec to Overall OAS	Québec	Ratio Québec to Overall OAS
65-69	0.0199	0.98	0.0215	1.06	0.0119	1.01	0.0116	0.98
70-74	0.0322	0.98	0.0348	1.06	0.0191	1.00	0.0189	0.99
75-79	0.0522	0.98	0.0564	1.06	0.0317	1.00	0.0319	1.00
80-84	0.0844	0.98	0.0909	1.06	0.0545	0.99	0.0560	1.02
85-89	0.1360	0.99	0.1438	1.04	0.0966	1.00	0.0986	1.02
90-94	0.2074	0.99	0.2131	1.02	0.1619	1.00	0.1631	1.01
95-99	0.2956	1.00	0.2955	1.00	0.2481	1.00	0.2480	1.00
100+	0.3964	1.00	0.3980	1.00	0.3502	1.00	0.3506	1.00

Chart 13 OAS Beneficiary Mortality Ratios by Place of Residence (2001)



b) Canada less Québec Residents with and without a CPP Retirement Benefit

For OAS beneficiaries residing in Canada less Québec and receiving a CPP retirement benefit, mortality ratios generally increase with age, except at the very advanced ages for both sexes (see Table 18 and Chart 14). Male mortality rates start below overall male OAS rates, but eventually exceed them, whereas female rates remain below their overall rates and show a greater relative increase.

For OAS beneficiaries residing in Canada less Québec and not receiving a CPP retirement benefit, mortality ratios generally decrease with age, especially for males. Female mortality rates for this group converge to overall OAS rates.

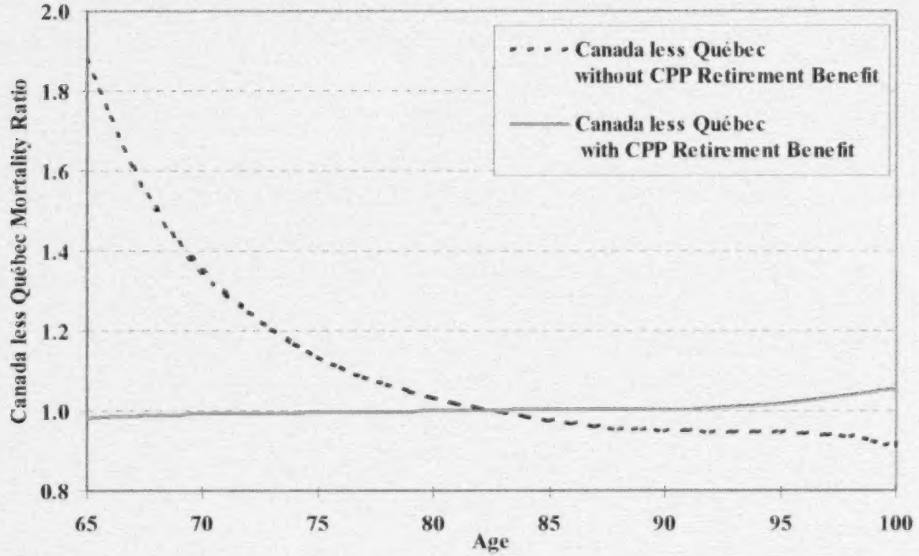
The ability to have been part of the labour force and to have contributed to the CPP is a significant predictor of mortality experience. Mortality rates and other life table statistics for OAS beneficiaries in receipt of the CPP retirement benefit are provided in Table 30 of Appendix A. Mortality ratios for Canada less Québec and for Québec residents by individual age are provided in Table 33 of the same appendix.

Table 18 OAS Beneficiary Mortality Rates of Canada less Québec Residents by Receipt of a CPP Retirement Benefit (2001)

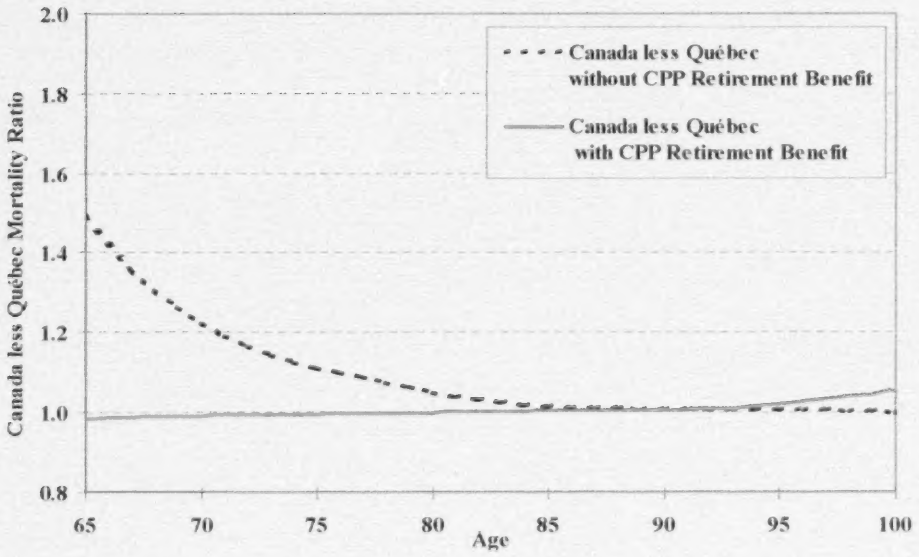
	Males				Females			
Age Group	Canada less Québec with CPP Retirement Benefit	Ratio Canada less Québec with CPP Retirement Benefit to Overall OAS	Canada less Québec without CPP Retirement Benefit	Ratio Canada less Québec without CPP Retirement Benefit to Overall OAS	Canada less Québec with CPP Retirement Benefit	Ratio Canada less Québec with CPP Retirement Benefit to Overall OAS	Canada less Québec without CPP Retirement Benefit	Ratio Canada less Québec without CPP Retirement Benefit to Overall OAS
65-69	0.0196	0.96	0.0320	1.58	0.0110	0.93	0.0163	1.38
70-74	0.0319	0.97	0.0405	1.24	0.0180	0.94	0.0224	1.18
75-79	0.0519	0.98	0.0574	1.08	0.0303	0.95	0.0348	1.09
80-84	0.0843	0.98	0.0863	1.01	0.0529	0.96	0.0567	1.03
85-89	0.1363	0.99	0.1323	0.96	0.0947	0.98	0.0981	1.01
90-94	0.2083	1.00	0.1985	0.95	0.1584	0.98	0.1638	1.01
95-99	0.3027	1.02	0.2820	0.95	0.2432	0.98	0.2503	1.01
100+	0.4002	1.01	0.3953	0.99	0.3389	0.97	0.3508	1.00

Chart 14 OAS Beneficiary Mortality Ratios of Canada less Québec Residents by Receipt of a CPP Retirement Benefit (2001)

Males



Females



The mortality ratios for those OAS beneficiaries residing in Canada less Québec and not receiving a CPP retirement benefit may be further analyzed by place of birth as shown in Table 19 and Chart 15. The lower mortality experience of immigrants can most probably be linked to Canadian immigration screening policies, which include an assessment of medical conditions.

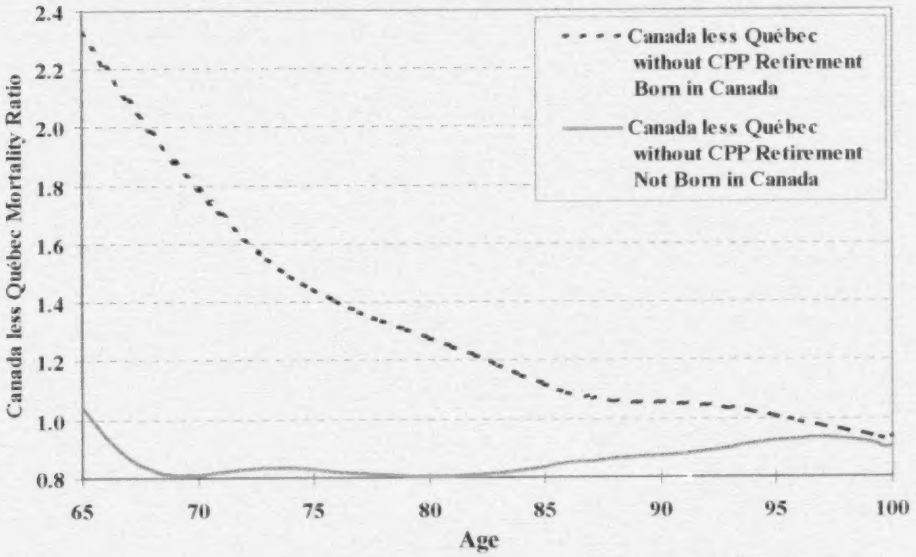
Those not born in Canada, or immigrants, experience much lower mortality compared to the overall OAS level for both sexes, and the converse is true for those born in Canada. In each case, the effect reduces as age increases. Moreover, male immigrants represent a higher proportion of those not entitled to CPP retirement benefits than for females, which explains the greater impact in the mortality ratios for males.

Table 19 OAS Beneficiary Mortality Rates of Canada less Québec Residents without CPP Retirement Benefits by Place of Birth (2001)

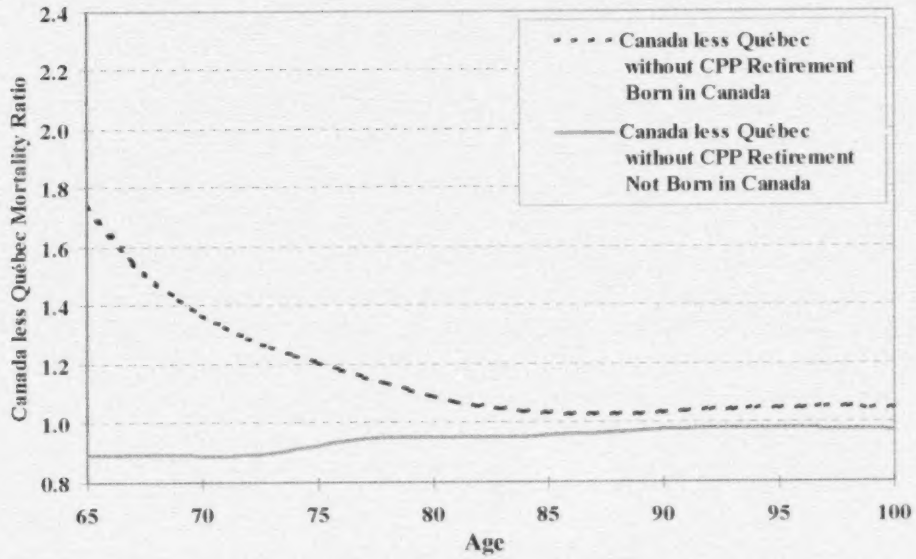
	Males				Females			
Age Group	Canada less Québec without CPP Retirement Benefit Born in Canada	Ratio Canada less Québec without CPP Retirement Benefit Born in Canada to Overall OAS	Canada less Québec without CPP Retirement Benefit Not Born in Canada	Ratio Canada less Québec without CPP Retirement Benefit Not Born in Canada to Overall OAS	Canada less Québec without CPP Retirement Benefit Born in Canada	Ratio Canada less Québec without CPP Retirement Benefit Born in Canada to Overall OAS	Canada less Québec without CPP Retirement Benefit Not Born in Canada	Ratio Canada less Québec without CPP Retirement Benefit Not Born in Canada to Overall OAS
65-69	0.0413	2.03	0.0177	0.87	0.0186	1.57	0.0108	0.91
70-74	0.0525	1.60	0.0271	0.82	0.0248	1.30	0.0173	0.91
75-79	0.0722	1.36	0.0432	0.81	0.0370	1.17	0.0303	0.95
80-84	0.1039	1.21	0.0695	0.81	0.0585	1.07	0.0526	0.96
85-89	0.1480	1.07	0.1176	0.85	0.0993	1.02	0.0940	0.97
90-94	0.2153	1.03	0.1862	0.89	0.1654	1.02	0.1599	0.99
95-99	0.2994	1.01	0.2784	0.94	0.2615	1.05	0.2446	0.99
100+	0.3998	1.01	0.3947	0.99	0.3567	1.02	0.3481	0.99

Chart 15 OAS Beneficiary Mortality Ratios of Canada less Québec Residents without CPP Retirement Benefits by Place of Birth (2001)

Males



Females



V. Life Expectancies

A comparison of life expectancies at age 65 between the various subgroups and the benchmark population is shown below in Table 20. The life expectancies shown in Table 20 do not include future mortality improvements.

Overall, since the mortality of OAS beneficiaries is higher than that of the benchmark, life expectancies at age 65 are correspondingly lower. The differential in life expectancies at age 65 between the overall OAS program and the benchmark is larger for males (0.5 year) than for females (0.4 year).

Those OAS beneficiaries who were born outside of Canada have greater life expectancies than those born in Canada. The differential for males is 1.6 years and for females, it is 1.2 years. For those born in Canada, the gap between female and male life expectancies is 3.7 years which is higher than the corresponding differential of 3.3 years for immigrants.

An analysis of the differential in life expectancies at age 65 by type of OAS benefit shows that males experience a wider range in life expectancies at age 65 between the wealthier and poorer OAS beneficiaries. The differential in life expectancies at age 65 between those who received clawback-reduced OAS benefits and those who received basic OAS and GIS benefits is 4.5 years for males and 3.4 years for females.

The gap in life expectancies at age 65 between the two sexes decreases the higher the level of income, from 4.0 for those receiving the GIS to 2.9 for those affected by the clawback.

Table 20 OAS Beneficiary Life Expectancies at Age 65 (2001)

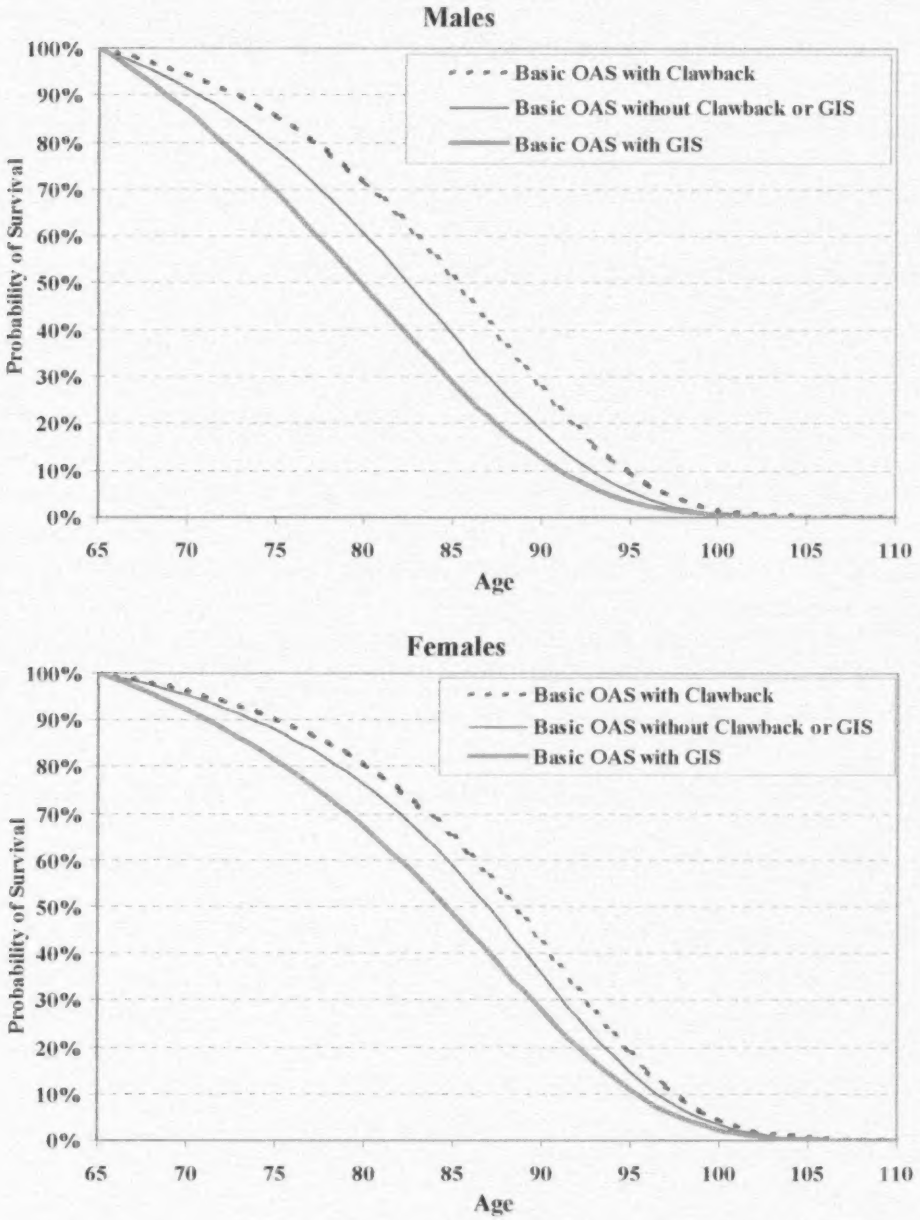
Type of Benefit	Males	Females	Female – Male Differential
OAS program	16.6	20.2	3.6
Benchmark	17.1	20.6	3.5
Differential between Benchmark & OAS program	0.5	0.4	
Born in Canada	16.2	19.9	3.7
Born outside of Canada (immigrants)	17.8	21.1	3.3
Differential between immigrants and born in Canada	1.6	1.2	
Basic OAS with GIS	15.0	19.0	4.0
Basic OAS without Clawback or GIS	17.2	21.1	3.9
Basic OAS with Clawback	19.5	22.4	2.9
Differential between OAS with Clawback and OAS with GIS	4.5	3.4	
Canada less Québec	16.8	20.2	3.4
Canada less Québec without CPP retirement benefit	15.4	19.5	4.1
Canada less Québec with CPP retirement benefit	16.8	20.5	3.7
Differential between Canada less Québec with and without CPP retirement benefit	1.4	1.0	

The probability of surviving from age 65 to a given age by type of benefit received is displayed by the survival curves for males and females in Chart 16. For each sex, the probabilities of survival increase as income increases corresponding to the type of benefit received. For example, the probability of a 65 year old male surviving to age 85 increases

from 29% for a GIS recipient to 51% if the clawback applies, and the corresponding probabilities for females are 49% and 65%.

The survival curves for each sex do not reflect much squaring as the mortality rates at the older ages follow a more gradual growth rather than an exponential growth. More of an expansion of the survival curves is seen for females than for males since females exhibit mortality rates that are more level at the advanced ages.

Chart 16 OAS Beneficiary Survival Curves at Age 65 by Type of Benefit (2001)



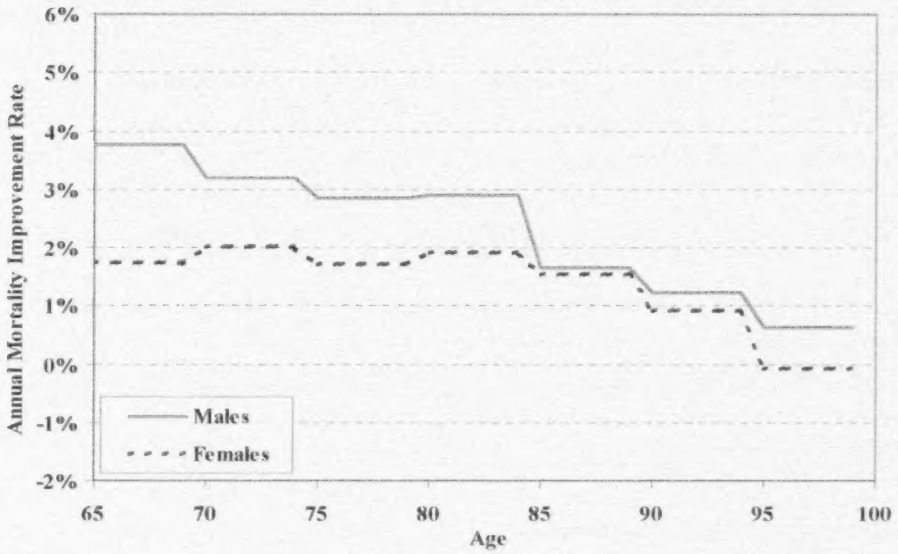
VI. Mortality Improvement Rates

Annual mortality improvement rates were determined as a by-product of the derivation of the 2001 base year crude mortality rates. The four different methods to derive the 2001 base year crude rates were considered. Of these, three used regression methodologies and thus could produce improvement rates.

Method 4 was determined to be the best method to produce the mortality improvement rates, and these rates are shown below in Chart 17. Except at the very advanced ages, male annual mortality improvement rates have been greater than for females and exhibit a clearer declining pattern with age.

Further discussion about the different methods considered and resulting improvement rates are provided in Appendix C.

Chart 17 OAS Beneficiary Annual Mortality Improvement Rates (2001)



Annual mortality improvement rates can be used to project mortality rates in the future. However, it is very important to note that the measurement of annual mortality improvement rates over a short period of five years (1999-2003) as used for this study should be interpreted with caution because of the relatively high level of statistical variance in the results. The same also applies for improvement rates at very advanced ages (95 and over) due to low exposures and greater variation of results. Future OAS mortality studies using longer time periods may reveal different results.

Tables 21 and 22 show the average annual mortality improvement rates of the OAS program by subgroup based on the year 2001. The overall mortality improvement rates of the OAS program (3.2% for males and 1.8% for females) are greater than those of the benchmark (2.3% for males and 1.4% for females).

Table 21 Male OAS Beneficiary Annual Mortality Improvement Rates (2001)

Age Group	Overall OAS Program	Benchmark Mortality	Basic OAS with Clawback	Basic OAS without Clawback or GIS	OAS with GIS	Canada less Québec	Canada less Québec with CPP Retirement Benefit	Canada less Québec without CPP Retirement Benefit
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
65-69	3.8	2.6	4.0	3.6	3.5	3.4	3.3	7.9
70-74	3.2	2.4	3.9	3.4	2.8	3.0	3.0	4.7
75-79	2.9	2.2	4.4	2.9	2.7	2.8	2.7	5.2
80-84	2.9	1.9	3.0	2.5	2.7	2.8	2.6	5.3
85-89	1.7	1.6	3.1	1.0	1.9	1.7	1.6	2.6
90-94	1.2	1.2	1.9	0.3	1.7	1.0	1.0	1.6
95-99	0.6	0.8	3.3	0.3	0.9	0.6	0.0	5.2
100+	-1.0	0.5	0.0	13.4	-3.2	0.5	0.0	3.3
65+	3.2	2.3	3.9	3.1	2.9	3.0	2.9	5.0
65-84	3.3	2.4	4.0	3.3	3.0	3.1	3.0	5.6
85+	1.5	1.5	2.9	0.8	1.8	1.5	1.4	2.6

Table 22 Female OAS Beneficiary Annual Mortality Improvement Rates (2001)

Age Group	Overall OAS Program	Benchmark Mortality	Basic OAS with Clawback	Basic OAS without Clawback or GIS	Basic OAS with GIS	Canada less Québec	Canada less Québec with CPP Retirement Benefit	Canada less Québec without CPP Retirement Benefit
	(%)	(%)	(%)	(%)	(%)	(%)	(%)	(%)
65-69	1.7	1.6	5.1	1.5	1.8	1.4	0.7	1.9
70-74	2.0	1.5	1.7	2.1	1.9	1.8	1.6	1.2
75-79	1.7	1.5	1.8	1.8	1.5	1.7	1.4	1.6
80-84	1.9	1.3	5.8	1.5	1.7	1.9	1.4	2.2
85-89	1.5	1.0	1.3	1.7	1.4	1.6	0.5	2.5
90-94	0.9	0.8	1.5	1.4	0.6	0.9	0.1	1.2
95-99	-0.1	0.6	0.8	-0.3	0.0	0.0	-2.4	0.7
100+	1.9	0.3	0.0	3.0	1.5	2.1	0.0	2.2
65+	1.8	1.4	3.0	1.7	1.6	1.6	1.1	1.8
65-84	1.8	1.5	3.3	1.7	1.7	1.7	1.2	1.7
85+	1.3	0.9	1.3	1.6	1.0	1.3	0.3	2.0

In general, annual mortality improvement rates for males have been greater than for females, and as a result the gap in mortality rates has been narrowing between the two sexes.

While male mortality improvement rates tend to diminish with age, this pattern is less noticeable for females. Both sexes have experienced greater improvement rates for those between the ages of 65 and 84 compared to those aged 85 and older. Annual mortality improvement rates for those in the age group 65 to 84 are 3.3% for males and 1.8% for females, while they are 1.5% for males and 1.3% for females for those 85 and older. At very advanced ages, annual mortality deterioration is observed for both sexes.

The analysis by type of OAS benefit reveals higher mortality improvement rates for those with a higher level of income. For example, males aged 65 and older who received a clawback-reduced OAS benefit experienced an annual improvement rate of 3.9% (3.0% for females) as compared to 2.9% (1.6% for females) to those who received both the OAS and income-tested GIS benefits.

VII. Conclusion

The availability and quality of the administrative OAS beneficiaries database provide sufficient and reliable data upon which this study is based and allow an accurate measurement of the level and trend in mortality experienced by the oldest portion of the Canadian population. The study shows that the level of OAS mortality based on the year 2001 is higher than the projected mortality from the 1995-1997 Life Tables for Canada by about 7% for males and 6% for females.

In general, GIS recipients experience higher mortality and thus lower life expectancies relative to the overall OAS population. In comparison, those who receive clawback-reduced OAS benefits experience lower mortality and higher life expectancies. This may be explained by the association between high levels of income and improved health and quality of life.

VIII. Appendices

A. Supplemental Tables

Table 23 OAS Beneficiary Deaths by Type of Benefit (1999-2003)

Age	OAS with Clawback		OAS without Clawback or GIS		OAS with GIS		OAS Program	
	Males	Females	Males	Females	Males	Females	Males	Females
65	387	67	5,024	3,048	3,207	2,242	8,617	5,356
66	482	98	5,358	3,408	4,064	2,755	9,904	6,260
67	500	117	5,809	3,584	4,460	2,996	10,769	6,697
68	512	113	6,375	3,787	4,796	3,320	11,682	7,220
69	548	123	6,996	4,223	5,151	3,605	12,694	7,951
70	616	171	7,661	4,483	5,549	3,948	13,826	8,602
71	716	203	8,141	4,754	5,482	4,424	14,339	9,380
72	701	231	8,641	5,133	5,557	4,754	14,898	10,117
73	871	274	9,029	5,558	5,838	5,183	15,738	11,015
74	876	283	9,615	5,954	6,182	5,651	16,673	11,888
75	909	289	10,015	6,273	6,262	6,183	17,186	12,744
76	1,024	316	10,484	6,778	6,329	6,780	17,837	13,873
77	1,036	362	10,922	7,207	6,402	7,320	18,360	14,888
78	1,052	414	11,069	7,647	6,459	8,071	18,580	16,131
79	1,069	447	11,221	7,942	6,542	8,659	18,831	17,048
80	1,051	439	11,019	8,057	6,588	8,947	18,658	17,442
81	1,008	444	10,577	7,881	6,537	9,493	18,121	17,818
82	915	484	9,624	7,649	6,452	10,081	16,990	18,214
83	905	456	9,260	7,731	6,359	10,251	16,524	18,437
84	897	495	8,716	7,526	6,277	10,927	15,890	18,947
85	886	502	8,334	7,712	6,252	11,447	15,472	19,661
86	782	491	7,900	7,648	5,976	11,683	14,657	19,822
87	678	504	7,231	7,479	5,778	11,936	13,687	19,918
88	663	433	6,421	7,016	5,294	11,962	12,378	19,411
89	553	473	5,377	6,399	4,746	11,337	10,675	18,208
90	443	469	4,490	5,745	4,264	10,690	9,196	16,904
91	363	354	3,635	5,240	3,852	10,080	7,850	15,673
92	305	335	2,978	4,455	3,233	9,233	6,515	14,022
93	212	295	2,203	3,903	2,689	8,235	5,104	12,432
94	179	255	1,730	3,172	2,172	7,107	4,080	10,534
95	152	218	1,217	2,580	1,715	5,954	3,084	8,751
96	116	144	964	1,976	1,299	4,903	2,379	7,023
97	94	128	639	1,547	926	3,923	1,659	5,598
98	51	98	419	1,143	720	3,026	1,190	4,266
99	29	68	276	788	529	2,298	834	3,153
100	11	52	168	593	303	1,638	481	2,283
101	15	17	119	361	222	1,208	356	1,586
102	5	19	75	225	129	763	208	1,006
103	3	16	33	150	91	502	127	667
104	2	6	14	106	39	322	55	433
105	3	5	9	60	25	173	37	237
106	2	0	5	24	17	123	24	147
107	0	2	3	16	10	50	13	67
108	0	1	2	7	5	33	7	41
109	0	0	1	4	3	17	4	21
110+	0	0	0	4	1	24	1	28
Total*	21,616	10,701	229,790	186,963	164,773	254,243	416,179	451,907

* Number of deaths may not total across categories due to uniform distribution of births and deaths assumption.

Table 24 OAS Beneficiary Deaths by Place of Residence (1999-2003)

	Canada less Québec		Québec		Canada less Québec with CPP Retirement Benefit		Canada less Québec without CPP Retirement Benefit	
Age	Males	Females	Males	Females	Males	Females	Males	Females
65	6,208	3,931	2,409	1,425	5,977	3,103	231	829
66	7,267	4,624	2,637	1,636	6,977	3,611	290	1,013
67	7,876	4,947	2,893	1,750	7,588	3,819	289	1,128
68	8,529	5,262	3,153	1,958	8,238	4,032	291	1,231
69	9,308	5,919	3,386	2,032	8,990	4,455	318	1,464
70	10,109	6,378	3,717	2,224	9,754	4,698	355	1,680
71	10,512	6,827	3,827	2,554	10,110	4,951	403	1,876
72	10,945	7,432	3,953	2,686	10,494	5,351	451	2,081
73	11,611	8,121	4,127	2,895	11,141	5,708	471	2,413
74	12,348	8,718	4,326	3,170	11,813	6,034	535	2,685
75	12,781	9,441	4,405	3,303	12,186	6,264	596	3,178
76	13,384	10,333	4,454	3,541	12,752	6,796	632	3,537
77	13,735	11,103	4,626	3,786	13,001	7,130	734	3,973
78	13,911	12,160	4,669	3,971	13,144	7,644	767	4,516
79	14,245	12,812	4,586	4,236	13,456	7,792	789	5,020
80	14,295	13,149	4,363	4,293	13,410	7,893	885	5,257
81	13,873	13,357	4,249	4,461	12,966	7,813	907	5,544
82	13,010	13,639	3,981	4,575	12,066	7,793	944	5,847
83	12,679	13,797	3,845	4,640	11,726	7,641	953	6,157
84	12,282	14,167	3,608	4,780	11,285	7,464	998	6,703
85	11,975	14,787	3,497	4,874	10,979	7,633	997	7,154
86	11,513	14,995	3,144	4,827	10,534	7,376	979	7,620
87	10,739	15,100	2,948	4,819	9,763	7,163	976	7,937
88	9,685	14,735	2,693	4,676	8,712	6,718	973	8,017
89	8,452	13,791	2,224	4,418	7,554	6,145	898	7,646
90	7,275	12,811	1,921	4,093	6,448	5,409	827	7,402
91	6,182	11,986	1,668	3,687	5,471	4,803	711	7,184
92	5,197	10,698	1,319	3,324	4,550	4,035	647	6,664
93	4,082	9,445	1,022	2,987	3,498	3,445	585	6,000
94	3,279	8,115	802	2,419	2,809	2,742	470	5,373
95	2,453	6,677	631	2,075	2,060	2,082	393	4,595
96	1,908	5,318	471	1,705	1,551	1,524	358	3,794
97	1,344	4,384	315	1,214	1,069	1,214	275	3,170
98	966	3,309	224	957	729	788	237	2,521
99	689	2,466	145	688	504	493	185	1,973
100	378	1,789	103	494	240	303	138	1,487
101	284	1,256	72	330	172	204	112	1,052
102	167	802	41	204	78	103	90	699
103	101	514	26	153	40	50	61	464
104	37	333	18	100	13	22	24	312
105	27	191	11	46	5	7	22	185
106	17	113	7	34	2	4	15	109
107	10	57	3	11	0	1	10	56
108	7	34	0	7	0	0	7	34
109	1	17	3	4	0	0	1	17
110+	1	22	0	6	0	0	1	22
Total*	315,668	339,849	100,511	112,058	293,846	182,245	21,822	157,605

* Number of deaths may not total across categories due to uniform distribution of births and deaths assumption.

Table 25 OAS Beneficiary Exposures by Place of Birth (1999-2003)

	Born in Canada		Born Outside of Canada		OAS Program	
Age	Males	Females	Males	Females	Males	Females
65	376,084	408,312	145,483	144,190	521,567	552,502
66	385,348	422,025	150,102	147,725	535,451	569,750
67	381,044	421,635	147,546	144,643	528,590	566,278
68	374,242	419,872	145,011	142,343	519,252	562,214
69	366,449	417,224	142,205	140,522	508,654	557,746
70	355,535	412,486	138,421	139,117	493,955	551,603
71	341,373	404,275	134,776	138,991	476,150	543,266
72	323,553	391,404	130,721	140,078	454,274	531,482
73	305,453	378,206	125,682	141,076	431,135	519,282
74	287,512	366,133	119,273	140,888	406,784	507,021
75	270,123	354,758	113,004	140,094	383,127	494,852
76	251,622	343,686	105,834	136,449	357,456	480,135
77	235,677	335,551	97,965	130,206	333,642	465,757
78	218,483	324,227	89,487	121,854	307,970	446,081
79	200,349	310,103	81,039	112,778	281,389	422,881
80	179,752	290,421	69,409	98,946	249,161	389,368
81	161,088	270,151	57,862	85,415	218,950	355,566
82	141,669	247,510	48,086	73,390	189,754	320,900
83	123,886	226,147	39,981	63,198	163,868	289,345
84	107,813	205,376	33,571	55,282	141,384	260,658
85	93,753	187,300	30,234	51,804	123,987	239,104
86	78,843	166,382	27,553	49,236	106,396	215,618
87	64,845	144,233	24,684	46,429	89,528	190,662
88	51,186	121,001	21,958	43,946	73,144	164,947
89	38,124	96,212	20,188	43,314	58,313	139,526
90	27,092	72,574	18,530	43,436	45,621	116,009
91	18,580	53,077	16,528	41,919	35,108	94,996
92	12,212	37,564	14,218	38,837	26,430	76,401
93	7,893	25,966	11,545	34,288	19,438	60,254
94	5,242	18,260	8,726	28,004	13,968	46,265
95	3,554	13,275	6,283	21,634	9,838	34,909
96	2,346	9,535	4,372	16,170	6,718	25,705
97	1,503	6,759	2,934	11,648	4,437	18,407
98	960	4,653	1,935	8,210	2,895	12,862
99	601	3,174	1,231	5,634	1,833	8,808
100	388	2,080	750	3,716	1,138	5,796
101	219	1,327	471	2,423	690	3,751
102	119	829	279	1,524	398	2,353
103	69	497	148	927	217	1,424
104	35	289	88	542	124	831
105	20	171	46	297	66	468
106	13	89	26	150	39	238
107	6	45	13	80	19	125
108	2	21	6	42	8	63
109	0	10	3	21	3	31
110+	0	15	5	29	5	44
Total*	5,794,660	7,914,840	2,328,213	2,931,442	8,122,873	10,846,282

* Exposures may not total across categories due to rounding.

Table 26 OAS Beneficiary Exposures by Type of Benefit (1999-2003)

	OAS with Clawback		OAS without Clawback or GIS		OAS with GIS		OAS Program	
Age	Males	Females	Males	Females	Males	Females	Males	Females
65	41,430	10,861	340,522	375,606	139,615	166,035	521,567	552,502
66	47,291	13,635	335,224	377,397	152,935	178,717	535,451	569,750
67	45,320	14,454	328,845	368,227	154,425	183,597	528,590	566,278
68	41,166	13,799	326,020	360,805	152,066	187,611	519,252	562,214
69	38,660	13,604	321,602	353,709	148,391	190,433	508,654	557,746
70	37,846	14,335	313,581	345,600	142,529	191,668	493,955	551,603
71	40,737	17,210	299,967	334,448	135,445	191,608	476,150	543,266
72	38,766	17,582	286,236	321,965	129,272	191,935	454,274	531,482
73	38,223	19,013	270,225	308,277	122,687	191,992	431,135	519,282
74	35,875	18,521	255,288	296,297	115,621	192,203	406,784	507,021
75	33,436	17,900	240,794	284,485	108,897	192,468	383,127	494,852
76	31,107	17,241	224,812	271,323	101,537	191,571	357,456	480,135
77	28,793	16,422	210,180	258,324	94,670	191,012	333,642	465,757
78	26,377	15,590	193,812	242,042	87,781	188,449	307,970	446,081
79	23,560	14,711	176,250	223,508	81,579	184,662	281,389	422,881
80	20,469	13,519	154,431	199,119	74,261	176,729	249,161	389,368
81	17,486	12,293	133,598	175,120	67,865	168,153	218,950	355,566
82	14,611	10,938	113,718	152,061	61,426	157,901	189,754	320,900
83	12,260	9,656	96,196	131,818	55,412	147,872	163,868	289,345
84	10,190	8,600	81,303	114,477	49,892	137,581	141,384	260,658
85	8,694	7,796	70,149	101,750	45,145	129,558	123,987	239,104
86	7,177	6,845	59,371	88,908	39,849	119,865	106,396	215,618
87	5,865	5,935	48,870	76,059	34,794	108,668	89,528	190,662
88	4,649	5,015	38,875	63,289	29,620	96,643	73,144	164,947
89	3,504	4,108	30,099	51,644	24,709	83,774	58,313	139,526
90	2,653	3,236	22,786	41,515	20,183	71,258	45,621	116,009
91	1,981	2,618	16,965	33,024	16,163	59,354	35,108	94,996
92	1,438	2,083	12,298	25,710	12,695	48,608	26,430	76,401
93	1,057	1,629	8,673	19,615	9,708	39,011	19,438	60,254
94	755	1,245	6,026	14,508	7,187	30,512	13,968	46,265
95	515	917	4,108	10,536	5,214	23,457	9,838	34,909
96	345	627	2,717	7,476	3,656	17,603	6,718	25,705
97	203	433	1,710	5,170	2,524	12,804	4,437	18,407
98	119	299	1,061	3,479	1,714	9,084	2,895	12,862
99	74	187	632	2,315	1,127	6,306	1,833	8,808
100	47	107	385	1,485	706	4,205	1,138	5,796
101	24	67	213	928	453	2,756	690	3,751
102	12	45	119	561	267	1,747	398	2,353
103	7	24	67	349	143	1,051	217	1,424
104	6	13	38	202	79	616	124	831
105	3	5	21	107	42	356	66	468
106	0	2	13	55	26	181	39	238
107	0	1	7	29	11	95	19	125
108	0	0	2	14	6	49	8	63
109	0	0	0	8	3	23	3	31
110+	0	1	0	5	5	37	5	44
Total*	662,730	333,120	5,027,808	6,043,346	2,432,335	4,469,816	8,122,873	10,846,282

* Exposures may not total across categories due to rounding.

Table 27 OAS Beneficiary Exposures by Place of Residence and Receipt of a CPP Retirement Benefit (1999-2003)

	Canada less Québec		Québec		Canada less Québec with CPP Retirement Benefit		Canada less Québec without CPP Retirement Benefit	
Age	Males	Females	Males	Females	Males	Females	Males	Females
65	388,746	405,825	132,821	146,677	380,741	348,351	8,005	57,474
66	399,410	418,162	136,041	151,588	390,972	354,166	8,437	63,996
67	393,854	414,646	134,735	151,632	385,261	345,930	8,593	68,716
68	387,424	411,241	131,829	150,973	378,495	337,279	8,928	73,962
69	379,948	407,744	128,705	150,002	370,653	328,427	9,295	79,317
70	369,423	403,283	124,532	148,320	359,675	318,472	9,748	84,811
71	356,986	397,444	119,163	145,823	346,735	307,287	10,251	90,157
72	341,798	389,993	112,475	141,489	331,135	294,896	10,663	95,097
73	325,006	382,249	106,129	137,033	313,918	282,305	11,087	99,944
74	307,355	374,567	99,429	132,454	295,971	270,261	11,385	104,306
75	290,348	367,049	92,779	127,804	278,654	258,764	11,694	108,284
76	272,035	357,767	85,421	122,368	260,182	246,214	11,853	111,553
77	254,916	348,470	78,726	117,288	242,916	233,810	12,000	114,659
78	236,695	335,146	71,275	110,935	224,703	219,342	11,992	115,804
79	217,753	319,225	63,636	103,656	205,869	203,415	11,884	115,810
80	193,594	294,383	55,567	94,985	182,091	182,505	11,503	111,878
81	170,374	268,552	48,576	87,013	159,355	161,609	11,019	106,943
82	148,204	242,419	41,551	78,480	137,902	141,112	10,301	101,307
83	128,274	218,394	35,594	70,952	118,679	122,588	9,594	95,806
84	110,988	196,662	30,396	63,996	102,039	106,083	8,949	90,579
85	97,752	181,036	26,236	58,068	89,423	94,056	8,328	86,980
86	84,350	164,070	22,046	51,548	76,789	82,057	7,561	82,013
87	71,085	145,245	18,443	45,417	64,222	70,020	6,863	75,225
88	58,191	125,889	14,954	39,058	52,182	58,383	6,009	67,506
89	46,397	106,454	11,916	33,072	41,270	47,345	5,126	59,109
90	36,346	88,390	9,276	27,619	32,048	37,539	4,298	50,851
91	28,063	72,426	7,046	22,570	24,520	29,295	3,542	43,131
92	21,201	58,245	5,230	18,156	18,363	22,507	2,838	35,738
93	15,548	45,991	3,890	14,263	13,307	16,819	2,240	29,172
94	11,169	35,401	2,799	10,864	9,414	12,118	1,755	23,283
95	7,880	26,768	1,958	8,141	6,512	8,534	1,368	18,234
96	5,424	19,795	1,294	5,910	4,358	5,850	1,065	13,945
97	3,599	14,298	838	4,108	2,803	3,802	796	10,496
98	2,341	10,007	554	2,855	1,740	2,318	601	7,690
99	1,480	6,886	353	1,922	1,010	1,392	470	5,494
100	922	4,545	216	1,252	579	830	342	3,715
101	555	2,951	135	800	318	443	237	2,508
102	318	1,839	80	514	152	227	166	1,612
103	170	1,109	48	315	66	105	104	1,004
104	94	651	30	180	26	42	67	609
105	50	366	16	102	6	14	44	352
106	30	185	9	53	2	3	28	182
107	13	97	6	27	0	0	12	97
108	5	45	3	18	0	0	5	45
109	2	22	1	9	0	0	2	22
110+	5	33	0	11	0	0	5	33
Total*	6,166,117	8,065,964	1,956,757	2,780,318	5,905,059	5,556,519	261,058	2,509,445

* Exposures may not total across categories due to rounding.

Table 28 Number of OAS Beneficiaries in Pay (1999-2003)

As at 31st December	1999		2000		2001		2002		2003	
Age	Males	Females	Males	Females	Males	Females	Males	Females	Males	Females
65	101,708	108,835	104,055	111,230	105,836	112,119	105,798	113,038	103,112	109,896
66	104,757	110,914	104,599	112,345	106,119	113,862	107,826	114,936	108,373	116,114
67	106,770	114,525	103,466	110,401	103,689	111,979	105,125	113,579	107,207	114,703
68	104,260	113,326	104,947	113,692	101,922	109,624	102,224	111,327	103,963	112,931
69	103,047	113,286	102,175	112,345	102,914	112,662	100,151	108,756	100,769	110,501
70	95,162	107,832	100,736	112,106	100,015	111,240	100,822	111,550	98,336	107,770
71	92,407	107,333	92,699	106,472	98,313	110,742	97,654	110,020	98,636	110,274
72	87,749	104,463	89,870	105,749	90,141	104,987	95,864	109,287	95,269	108,495
73	83,486	102,873	85,042	102,800	87,311	104,046	87,521	103,474	93,188	107,597
74	78,963	101,862	80,383	100,903	82,237	101,014	84,505	102,175	84,715	101,690
75	74,137	98,934	76,002	99,621	77,253	98,774	79,263	98,988	81,486	100,100
76	68,602	94,445	70,836	96,596	72,811	97,266	74,016	96,495	76,091	96,741
77	64,307	92,173	65,209	91,801	67,428	93,923	69,523	94,663	70,642	93,938
78	60,626	88,640	60,761	89,285	61,723	89,065	63,889	91,146	66,086	91,833
79	54,859	83,233	56,973	85,323	57,304	86,271	58,238	86,085	60,339	88,011
80	43,710	69,356	51,084	79,844	53,112	82,053	53,763	83,038	54,585	82,880
81	38,997	64,410	40,380	66,188	47,312	76,366	49,437	78,562	50,134	79,493
82	34,312	58,440	35,778	61,152	37,160	62,890	43,700	72,583	45,580	74,708
83	31,090	55,142	31,197	55,083	32,655	57,692	34,017	59,427	40,044	68,658
84	27,912	51,709	27,903	51,589	28,154	51,553	29,520	53,960	30,769	55,856
85	24,943	48,165	24,835	47,956	24,854	47,958	25,178	47,936	26,480	50,104
86	20,511	41,797	21,915	44,062	21,834	43,957	21,901	44,168	22,271	44,252
87	17,128	36,587	17,804	37,929	18,997	40,098	19,034	39,937	19,080	40,257
88	13,183	30,249	14,600	32,758	15,215	34,011	16,237	36,007	16,323	35,916
89	10,856	26,267	11,070	26,727	12,255	28,955	12,863	30,213	13,621	32,002
90	8,468	21,705	8,992	22,905	9,214	23,395	10,183	25,318	10,665	26,468
91	6,692	18,209	6,821	18,558	7,334	19,651	7,475	20,097	8,290	21,802
92	5,130	14,492	5,234	15,283	5,408	15,647	5,801	16,688	5,956	16,922
93	3,617	11,251	4,014	11,994	4,022	12,490	4,225	12,883	4,553	13,852
94	2,552	8,826	2,747	9,148	3,010	9,640	3,056	10,104	3,211	10,400
95	1,838	6,456	1,859	6,904	2,019	7,273	2,197	7,615	2,305	8,029
96	1,327	4,989	1,318	4,952	1,354	5,303	1,460	5,610	1,596	5,916
97	888	3,586	928	3,758	889	3,741	951	3,981	1,033	4,224
98	568	2,424	592	2,597	626	2,712	592	2,771	657	2,872
99	347	1,722	359	1,748	379	1,812	402	1,893	376	1,965
100+	549	2,939	537	3,045	540	3,108	563	3,230	594	3,436
Total	1,575,458	2,121,395	1,607,720	2,154,849	1,641,359	2,187,879	1,674,974	2,221,540	1,706,335	2,250,606

Table 29 Life Table of OAS Beneficiaries (2001)

	Males				Females			
Age	l_x	q_x	d_x	$\mathring{e}_x$	l_x	q_x	d_x	$\mathring{e}_x$
65	100,000	0.0164	1,640	16.63	100,000	0.0098	980	20.22
66	98,360	0.0182	1,790	15.90	99,020	0.0107	1,060	19.42
67	96,570	0.0202	1,951	15.18	97,960	0.0117	1,146	18.62
68	94,619	0.0223	2,110	14.49	96,814	0.0129	1,249	17.84
69	92,509	0.0246	2,276	13.80	95,565	0.0141	1,347	17.06
70	90,233	0.0271	2,445	13.14	94,218	0.0155	1,460	16.30
71	87,788	0.0298	2,616	12.49	92,758	0.0171	1,586	15.55
72	85,172	0.0328	2,794	11.86	91,172	0.0189	1,723	14.81
73	82,378	0.0361	2,974	11.25	89,449	0.0209	1,869	14.09
74	79,404	0.0398	3,160	10.65	87,580	0.0231	2,023	13.38
75	76,244	0.0439	3,347	10.07	85,557	0.0256	2,190	12.68
76	72,897	0.0485	3,536	9.51	83,367	0.0284	2,368	12.00
77	69,361	0.0535	3,711	8.97	80,999	0.0316	2,560	11.34
78	65,650	0.0590	3,873	8.45	78,439	0.0352	2,761	10.69
79	61,777	0.0650	4,016	7.94	75,678	0.0393	2,974	10.06
80	57,761	0.0718	4,147	7.46	72,704	0.0440	3,199	9.45
81	53,614	0.0792	4,246	7.00	69,505	0.0493	3,427	8.87
82	49,368	0.0874	4,315	6.56	66,078	0.0553	3,654	8.30
83	45,053	0.0964	4,343	6.14	62,424	0.0622	3,883	7.76
84	40,710	0.1064	4,332	5.74	58,541	0.0699	4,092	7.24
85	36,378	0.1172	4,264	5.37	54,449	0.0786	4,280	6.74
86	32,114	0.1289	4,139	5.01	50,169	0.0883	4,430	6.28
87	27,975	0.1415	3,958	4.68	45,739	0.0989	4,524	5.83
88	24,017	0.1550	3,723	4.37	41,215	0.1107	4,563	5.42
89	20,294	0.1694	3,438	4.08	36,652	0.1235	4,527	5.03
90	16,856	0.1846	3,112	3.81	32,125	0.1375	4,417	4.67
91	13,744	0.2006	2,757	3.56	27,708	0.1525	4,225	4.34
92	10,987	0.2174	2,389	3.32	23,483	0.1686	3,959	4.03
93	8,598	0.2349	2,020	3.11	19,524	0.1856	3,624	3.74
94	6,578	0.2531	1,665	2.91	15,900	0.2034	3,234	3.48
95	4,913	0.2718	1,335	2.73	12,666	0.2219	2,811	3.24
96	3,578	0.2910	1,041	2.56	9,855	0.2409	2,374	3.02
97	2,537	0.3106	788	2.40	7,481	0.2605	1,949	2.82
98	1,749	0.3305	578	2.26	5,532	0.2804	1,551	2.64
99	1,171	0.3507	411	2.13	3,981	0.3007	1,197	2.48
100	760	0.3711	282	2.01	2,784	0.3211	894	2.33
101	478	0.3914	187	1.90	1,890	0.3415	645	2.20
102	291	0.4117	120	1.80	1,245	0.3616	450	2.07
103	171	0.4317	74	1.71	795	0.3813	303	1.97
104	97	0.4514	44	1.62	492	0.4004	197	1.87
105	53	0.4706	25	1.55	295	0.4186	123	1.78
106	28	0.4891	14	1.48	172	0.4359	75	1.71
107	14	0.5068	7	1.42	97	0.4521	44	1.64
108	7	0.5237	4	1.37	53	0.4669	25	1.59
109	3	0.5395	2	1.32	28	0.4804	13	1.54
110	1	0.5542	1	1.27	15	0.4923	7	1.50
111	0	0.5677	0	1.24	8	0.5027	4	1.46
112	0	0.5798	0	1.20	4	0.5115	2	1.43
113	0	0.5905	0	1.18	2	0.5188	1	1.41
114	0	0.5997	0	1.15	1	0.5245	1	1.39
115	0	0.6075	0	1.14	0	0.5289	0	1.37
120	0	0.6227	0	0.88	0	0.5353	0	0.96

Table 30 Life Table of OAS Beneficiaries in Receipt of a CPP Retirement Benefit (2001)

	Males				Females			
Age	l_x	q_x	d_x	$\mathring{e}_x$	l_x	q_x	d_x	$\mathring{e}_x$
65	100,000	0.0157	1,570	16.79	100,000	0.0090	900	20.50
66	98,430	0.0175	1,723	16.05	99,100	0.0099	981	19.68
67	96,707	0.0195	1,886	15.33	98,119	0.0110	1,079	18.87
68	94,821	0.0216	2,048	14.63	97,040	0.0121	1,174	18.07
69	92,773	0.0239	2,217	13.94	95,866	0.0133	1,275	17.29
70	90,556	0.0263	2,382	13.27	94,591	0.0147	1,390	16.51
71	88,174	0.0289	2,548	12.61	93,201	0.0162	1,510	15.75
72	85,626	0.0319	2,731	11.97	91,691	0.0179	1,641	15.00
73	82,895	0.0351	2,910	11.35	90,050	0.0198	1,783	14.27
74	79,985	0.0388	3,103	10.75	88,267	0.0220	1,942	13.55
75	76,882	0.0429	3,298	10.16	86,325	0.0244	2,106	12.84
76	73,584	0.0473	3,481	9.59	84,219	0.0271	2,282	12.15
77	70,103	0.0522	3,659	9.04	81,937	0.0302	2,474	11.47
78	66,444	0.0576	3,827	8.51	79,463	0.0338	2,686	10.82
79	62,617	0.0636	3,982	8.00	76,777	0.0378	2,902	10.18
80	58,635	0.0703	4,122	7.51	73,875	0.0425	3,140	9.56
81	54,513	0.0777	4,236	7.04	70,735	0.0478	3,381	8.96
82	50,277	0.0859	4,319	6.59	67,354	0.0538	3,624	8.38
83	45,958	0.0950	4,366	6.17	63,730	0.0607	3,868	7.83
84	41,592	0.1050	4,367	5.76	59,862	0.0685	4,101	7.31
85	37,225	0.1158	4,311	5.38	55,761	0.0771	4,299	6.81
86	32,914	0.1276	4,200	5.02	51,462	0.0868	4,467	6.33
87	28,714	0.1403	4,029	4.68	46,995	0.0975	4,582	5.89
88	24,685	0.1539	3,799	4.36	42,413	0.1092	4,631	5.47
89	20,886	0.1684	3,517	4.06	37,782	0.1219	4,606	5.08
90	17,369	0.1838	3,192	3.79	33,176	0.1356	4,499	4.71
91	14,177	0.2002	2,838	3.53	28,677	0.1504	4,313	4.37
92	11,339	0.2177	2,469	3.28	24,364	0.1662	4,049	4.06
93	8,870	0.2362	2,095	3.06	20,315	0.1829	3,716	3.77
94	6,775	0.2558	1,733	2.85	16,599	0.2006	3,330	3.50
95	5,042	0.2766	1,395	2.65	13,269	0.2193	2,910	3.26
96	3,647	0.2985	1,089	2.48	10,359	0.2388	2,474	3.03
97	2,558	0.3209	821	2.32	7,885	0.2591	2,043	2.82
98	1,737	0.3438	597	2.18	5,842	0.2799	1,635	2.64
99	1,140	0.3670	418	2.06	4,207	0.3011	1,267	2.47
100	722	0.3903	282	1.96	2,940	0.3226	948	2.32
101	440	0.3914	172	1.90	1,992	0.3442	686	2.18
102	268	0.4117	110	1.80	1,306	0.3657	478	2.06
103	158	0.4317	68	1.71	828	0.3813	316	1.97
104	90	0.4514	41	1.62	512	0.4004	205	1.87
105	49	0.4706	23	1.55	307	0.4186	129	1.78
106	26	0.4891	13	1.48	178	0.4359	78	1.71
107	13	0.5068	7	1.42	100	0.4521	45	1.64
108	6	0.5237	3	1.37	55	0.4669	26	1.59
109	3	0.5395	2	1.32	29	0.4804	14	1.54
110	1	0.5542	1	1.27	15	0.4923	7	1.50
111	0	0.5677	0	1.24	8	0.5027	4	1.46
112	0	0.5798	0	1.20	4	0.5115	2	1.43
113	0	0.5905	0	1.18	2	0.5188	1	1.41
114	0	0.5997	0	1.15	1	0.5245	1	1.39
115	0	0.6075	0	1.14	0	0.5289	0	1.37
120	0	0.6227	0	0.88	0	0.5353	0	0.96

Table 31 OAS Beneficiary Mortality Ratios by Place of Birth (2001)

	Ratio Born in Canada to Overall OAS		Ratio Born Outside of Canada to Overall OAS	
Age	Males	Females	Males	Females
65	1.09	1.10	0.76	0.70
66	1.09	1.10	0.77	0.71
67	1.09	1.09	0.77	0.73
68	1.09	1.09	0.77	0.74
69	1.08	1.08	0.78	0.76
70	1.08	1.07	0.79	0.78
71	1.08	1.07	0.80	0.80
72	1.07	1.07	0.81	0.82
73	1.07	1.06	0.83	0.83
74	1.07	1.06	0.84	0.85
75	1.06	1.05	0.85	0.86
76	1.06	1.05	0.86	0.87
77	1.06	1.04	0.87	0.89
78	1.05	1.04	0.87	0.90
79	1.05	1.03	0.88	0.91
80	1.04	1.03	0.88	0.92
81	1.04	1.02	0.88	0.92
82	1.04	1.02	0.89	0.93
83	1.04	1.02	0.89	0.94
84	1.03	1.02	0.89	0.94
85	1.03	1.01	0.90	0.95
86	1.03	1.02	0.91	0.95
87	1.03	1.02	0.92	0.95
88	1.03	1.02	0.93	0.96
89	1.03	1.02	0.94	0.96
90	1.03	1.02	0.95	0.97
91	1.03	1.02	0.96	0.97
92	1.03	1.02	0.97	0.98
93	1.03	1.02	0.97	0.98
94	1.03	1.02	0.98	0.99
95	1.03	1.02	0.99	0.99
96	1.03	1.02	0.99	0.99
97	1.02	1.03	0.99	0.99
98	1.02	1.03	0.99	0.99
99	1.02	1.03	0.99	0.98
100	1.03	1.04	0.99	0.98
101	1.00	1.04	1.00	0.98
102	1.00	1.05	1.00	0.98
103	1.00	1.00	1.00	1.00
104	1.00	1.00	1.00	1.00
105	1.00	1.00	1.00	1.00
106	1.00	1.00	1.00	1.00
107	1.00	1.00	1.00	1.00
108	1.00	1.00	1.00	1.00
109	1.00	1.00	1.00	1.00
110	1.00	1.00	1.00	1.00
120	1.00	1.00	1.00	1.00

Table 32 OAS Beneficiary Mortality Ratios by Type of Benefit (2001)

	Ratio OAS with Clawback to Overall OAS		Ratio of OAS without Clawback or GIS to Overall OAS		Ratio of OAS with GIS to Overall OAS	
Age	Males	Females	Males	Females	Males	Females
65	0.56	0.62	0.89	0.83	1.40	1.40
66	0.55	0.64	0.87	0.83	1.41	1.39
67	0.55	0.66	0.87	0.82	1.41	1.38
68	0.56	0.67	0.87	0.82	1.40	1.36
69	0.56	0.68	0.88	0.83	1.38	1.35
70	0.57	0.68	0.89	0.83	1.36	1.33
71	0.58	0.68	0.90	0.84	1.34	1.31
72	0.59	0.67	0.91	0.84	1.32	1.29
73	0.60	0.66	0.92	0.85	1.30	1.28
74	0.61	0.66	0.93	0.85	1.28	1.26
75	0.63	0.66	0.93	0.86	1.26	1.24
76	0.64	0.67	0.94	0.87	1.25	1.22
77	0.65	0.69	0.94	0.87	1.23	1.20
78	0.67	0.71	0.95	0.88	1.21	1.18
79	0.68	0.72	0.95	0.89	1.19	1.16
80	0.70	0.74	0.95	0.89	1.18	1.14
81	0.72	0.75	0.95	0.90	1.16	1.12
82	0.74	0.76	0.96	0.91	1.14	1.11
83	0.76	0.77	0.96	0.91	1.13	1.09
84	0.77	0.78	0.96	0.92	1.11	1.08
85	0.79	0.79	0.96	0.93	1.10	1.07
86	0.80	0.80	0.97	0.93	1.08	1.06
87	0.82	0.82	0.97	0.94	1.07	1.05
88	0.83	0.83	0.97	0.95	1.06	1.04
89	0.83	0.85	0.97	0.95	1.05	1.04
90	0.84	0.86	0.97	0.96	1.05	1.03
91	0.85	0.88	0.97	0.96	1.04	1.03
92	0.87	0.89	0.98	0.96	1.04	1.02
93	0.88	0.90	0.98	0.96	1.03	1.02
94	0.90	0.91	0.98	0.97	1.03	1.02
95	0.92	0.92	0.99	0.97	1.02	1.02
96	0.94	0.93	0.99	0.97	1.02	1.01
97	0.97	0.95	1.00	0.97	1.01	1.01
98	1.00	0.96	1.00	0.98	1.00	1.01
99	1.00	0.98	1.00	0.98	1.00	1.01
100	1.00	1.00	1.00	0.98	1.00	1.01
101	1.00	1.00	1.00	0.99	1.00	1.01
102	1.00	1.00	1.00	1.00	1.00	1.01
103	1.00	1.00	1.00	1.00	1.00	1.00
104	1.00	1.00	1.00	1.00	1.00	1.00
105	1.00	1.00	1.00	1.00	1.00	1.00
106	1.00	1.00	1.00	1.00	1.00	1.00
107	1.00	1.00	1.00	1.00	1.00	1.00
108	1.00	1.00	1.00	1.00	1.00	1.00
109	1.00	1.00	1.00	1.00	1.00	1.00
110	1.00	1.00	1.00	1.00	1.00	1.00
120	1.00	1.00	1.00	1.00	1.00	1.00

Table 33 OAS Beneficiary Mortality Ratios by Place of Residence and Receipt of a CPP Retirement Benefit (2001)

	Ratio Canada less Québec to Overall OAS		Ratio Québec to Overall OAS		Ratio Canada less Québec with CPP Retirement Benefit to Overall OAS		Ratio Canada less Québec without CPP Retirement Benefit to Overall OAS	
Age	Males	Females	Males	Females	Males	Females	Males	Females
65	0.97	1.00	1.08	1.00	0.98	0.92	1.88	1.49
66	0.98	1.01	1.06	0.98	0.98	0.92	1.73	1.42
67	0.98	1.01	1.06	0.98	0.99	0.93	1.61	1.36
68	0.98	1.01	1.06	0.98	0.99	0.93	1.50	1.31
69	0.98	1.01	1.06	0.98	0.99	0.94	1.42	1.26
70	0.98	1.01	1.06	0.98	0.99	0.94	1.35	1.22
71	0.98	1.00	1.06	0.99	0.99	0.94	1.29	1.19
72	0.98	1.00	1.06	1.00	0.99	0.95	1.25	1.16
73	0.98	1.00	1.06	1.00	0.99	0.95	1.20	1.14
74	0.98	1.00	1.06	1.00	0.99	0.95	1.17	1.12
75	0.98	1.00	1.06	1.00	0.99	0.95	1.14	1.11
76	0.98	1.00	1.06	1.00	0.99	0.95	1.11	1.10
77	0.98	1.00	1.06	1.00	1.00	0.96	1.08	1.09
78	0.98	1.00	1.06	1.01	1.00	0.96	1.06	1.07
79	0.98	1.00	1.06	1.01	1.00	0.96	1.05	1.06
80	0.98	1.00	1.06	1.01	1.00	0.97	1.03	1.05
81	0.98	0.99	1.06	1.02	1.00	0.97	1.02	1.04
82	0.98	0.99	1.06	1.02	1.00	0.98	1.01	1.03
83	0.98	0.99	1.06	1.02	1.00	0.98	1.00	1.02
84	0.98	0.99	1.06	1.02	1.00	0.99	0.98	1.02
85	0.99	0.99	1.05	1.02	1.00	0.99	0.97	1.01
86	0.99	0.99	1.05	1.02	1.00	0.99	0.97	1.01
87	0.99	0.99	1.05	1.02	1.00	0.99	0.96	1.01
88	0.99	1.00	1.04	1.01	1.00	0.99	0.95	1.01
89	0.99	1.00	1.04	1.01	1.00	0.99	0.95	1.01
90	0.99	1.00	1.03	1.01	1.00	0.99	0.95	1.01
91	0.99	1.00	1.03	1.01	1.00	0.99	0.95	1.01
92	0.99	1.00	1.02	1.01	1.01	0.99	0.95	1.01
93	1.00	1.00	1.01	1.00	1.01	0.99	0.95	1.01
94	1.00	1.00	1.01	1.00	1.01	0.99	0.95	1.01
95	1.00	1.00	1.01	1.00	1.02	0.99	0.94	1.01
96	1.00	1.00	1.00	1.00	1.03	0.99	0.94	1.00
97	1.00	1.00	1.00	1.00	1.03	0.99	0.94	1.00
98	1.00	1.00	0.99	1.00	1.04	1.00	0.93	1.00
99	1.00	1.00	0.99	1.00	1.05	1.00	0.93	1.00
100	1.00	1.00	0.99	1.00	1.06	1.00	0.92	1.00
101	1.00	1.00	1.00	1.00	1.00	1.01	1.00	1.00
102	1.00	1.00	1.00	1.00	1.00	1.01	1.00	0.99
103	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
104	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
105	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
106	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
107	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
108	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
109	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
110	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
120	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

B. Derivation of Annual Crude Mortality Rates

Three different methods that may be used to determine crude mortality rates are briefly described in this section. Of the three methods, the product-limit estimator method was chosen for this study as explained below.

(i) Balducci Method

This method has traditionally been used by the OCA to study mortality. Its main advantage is that it simplifies exposure calculations to a certain extent, while its main disadvantage is that it may lose some accuracy at the advanced ages since exposures beyond the date of death are accounted for. While the Balducci method is still a valid method to calculate mortality rates, it is not based on statistical considerations.

(ii) Constant Force of Mortality Method

Under this method, the force of mortality, $\mu(x)$, is assumed to be constant for each age (x). This yields central rates of mortality at each age, m_x, defined as the ratio of deaths to exposures, which are constant and equal to $\mu(x)$. The crude mortality rates are subsequently derived from the formula $q_x = 1-e^{-m_x}$. Though the crude mortality rates are simple to determine, it is debatable whether a constant force of mortality assumption is valid at the advanced ages.

(iii) Product-Limit Estimator (PLE) Method

With the advent of calculators, and later, of computers, methods to estimate crude mortality rates have improved, and the PLE[1] method is such an example. This method produces survival rates from which mortality rates are easily obtained, whereas other methods produce mortality rates by taking ratios of deaths to exposures. The PLE method does not use exposures, but rather considers the product of survival probabilities across age intervals.

Between two consecutive ages, the one-year interval is divided into subintervals of half a month. For each subinterval i = 0, 1, 2,...23, an estimate is made of the number of people age $(x) + {}^{i}/_{24}$ observed at the beginning of the subinterval i, $N_x(i)$, and the number of deaths between ages $(x) + {}^{i}/_{24}$ and $(x) + {}^{(i+1)}/_{24}$ observed during the subinterval i to (i+1), $D_x(i)$. A survival rate $p_x(i)$ for the subinterval is then estimated by the ratio of the number of people surviving the subinterval to the number of people observing at the beginning of the subinterval, such that $p_x(i) = (N_x(i)-D_x(i))/N_x(i)$.

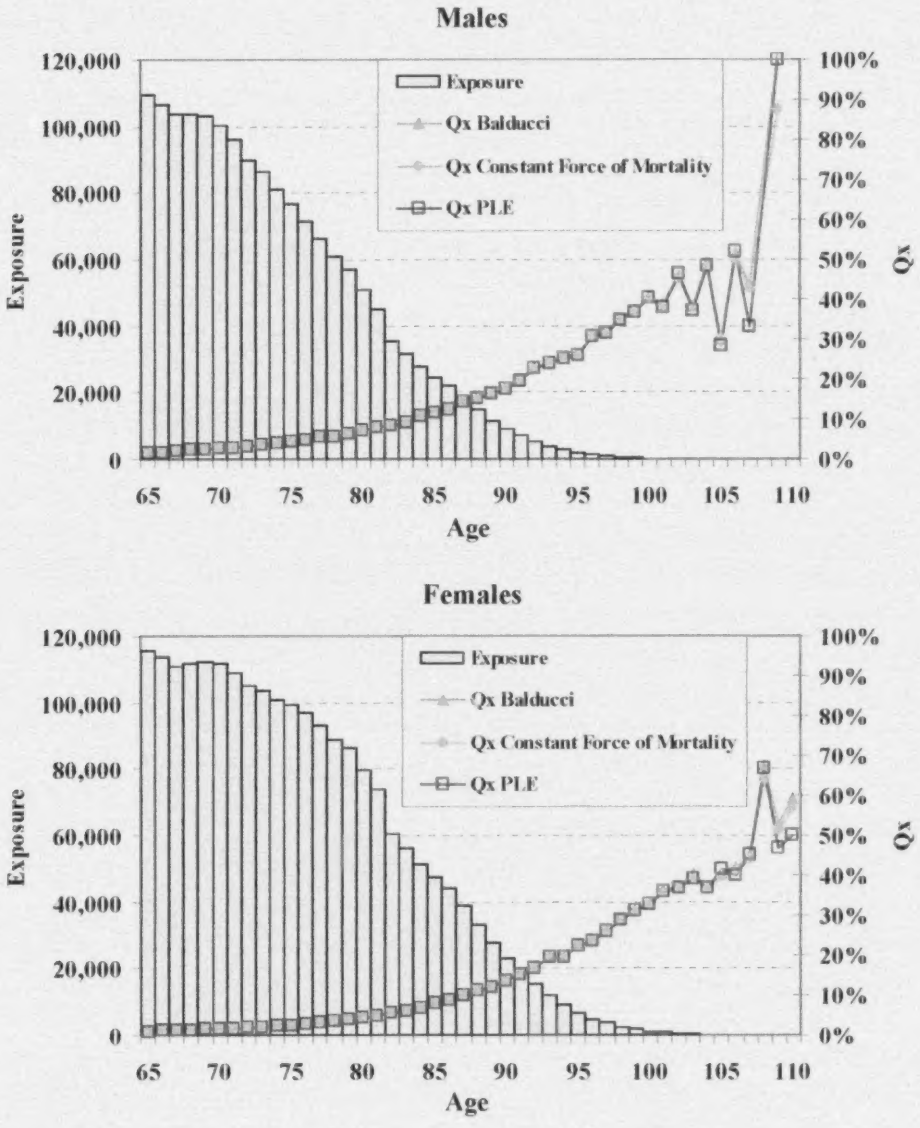
The annual crude survival rate, p_x, is then estimated as the product of the 24 $p_x(i)$ survival rates within the one-year age interval. Some adjustments are made for incomplete ages. For example, the adjustment at age 65 of $p_{65}^{adj} \cong p_{65}^{24/23}$ was made to take into account the fact that the age of OAS entitlement is defined to be at the beginning of the month after the 65th birthday. For each age (x), the annual crude mortality rate, q_x, is then determined simply as $1-p_x$.

[1] Also referred to as the Kaplan-Meier Estimator.

The PLE method produces estimators that are more complex to generate and have higher variance, but that are said to be true maximum likelihood estimators (under certain conditions) of crude mortality rates.[1]

A comparison of the results produced by the three methods described above is shown in Chart 18. Except at the advanced ages, the three methods measure mortality rates at about the same level. The annual crude mortality rates in this study are derived from the PLE method because of its sound statistical basis and the fact that it does not require any particular mortality assumption.

Chart 18 OAS Beneficiary Annual Crude Mortality Rates by Method (2001)



[1] Broffitt J., Maximum Likelihood Alternatives to Actuarial Estimators of Mortality Rates, Transactions of Society of Actuaries 1984 Vol. 36.

C. Derivation of 2001 Base Year Crude Mortality Rates

The 2001 base year crude mortality rates are based on the observation period spanning from 1999 to 2003. The use of five years of data reduces statistical fluctuations that may result if only one year of data were used. Four methods were developed to derive the base rates from the annual crude mortality rates over the five years. Among these four methods, three of them (Methods 2, 3, and 4) adjust the resulting rates by explicitly taking into account mortality improvements that are expected to be observed over the five-year period.

Methods 2, 3, and 4 all use least squares linear regression models in order to explicitly take into account mortality improvements. The use of least squares regression methodologies to produce base rates and improvement factors at the same time is not trivial. The use of least squares regression produces two sets of results: base mortality rates adjusted for mortality improvements and mortality improvement factors.

The following describes all four methods.

1. Method 1 is the Product-Limit Estimator method applied to the aggregated number of beneficiaries, N_x, and number of deaths, D_x, over the five-year period of the study. As compared to Method 2 (see below), its main drawback is that it does not account explicitly for multiplicative annual mortality improvement factors; however, since it is based on only five years of data, it produces values close to those obtained by Method 2.

2. Method 2 consists of five-year least squares regressions on the natural logarithm (ln) of the annual crude mortality rates performed separately for each possible combination of age, sex and subcategories. The least squares regressions allow for the derivation of the 2001 base year crude rates and the mortality improvement rates at the same time.

   Five data points (one for each year from 1999 to 2003) are used to obtain a 2001 base year crude mortality rate for a particular age (x), which accounts for a multiplicative mortality improvement factor (MMIF). The mortality improvement factor is simply 1-MMIF. For example, a MMIF of 0.97 results in a mortality improvement factor of 0.03 or 3%. The simplified mathematical model is:

   $$q_x^{year} = q_x^{2001} * MMIF_x^{year-2001} \rightarrow \ln(q_x^{year}) = \ln(q_x^{2001}) + (year-2001) * \ln(MMIF_x),$$

   where q_x^{year} is the crude mortality rate for a given year and age (x) obtained via the Product-Limit Estimator method, as described earlier.

3. Method 3 consists of five-year and five-age least squares regressions to estimate a set of five central rates of mortality (m_x) for any combination of age, sex and subcategories. Methods 3 and 4 both use twenty-five data points to produce different mortality rates for five successive ages while producing only one average mortality improvement factor for the corresponding quinquennial age group. Unlike the other three methods, Method 3 does not require the annual crude mortality rates since it produces the central rates of mortality from basic exposures

and deaths. For ages (x) between x_0 and x_{0+4} (where x_0 is age 65, 70, 75, etc.) the mathematical model uses a multiplicative survival improvement factor (MSIF) for each age group. The crude survival rates, p_x, are transformed into mortality rates, q_x, in order to compute the resulting mortality improvement factors. The model is of the form:

$$p_x^{year} = p_x^{2001} * (MSIF_{xo})^{year-2001} \rightarrow -\ln(p_x^{year}) = -\ln(p_x^{2001}) - (year-2001)*\ln(MSIF_{xo}),$$

where p_x^{year} is the crude survival rate for a given year and age (x) obtained by the Product-Limit Estimator method, as described earlier.

Under a constant force of mortality assumption, this simplifies to:

$$m_x^{year} = m_x^{2001} - (year-2001)*\ln(MSIF_{xo})$$

$$D_x^{year}/E_x^{year} = m_x^{2001} - (year-2001)*\ln(MSIF_{xo}),$$

where D_x and E_x are the number of deaths and exposures, respectively, for age (x). This method produces five central rates of mortality for any combination of subcategories and one MSIF for each quinquennial age group.

4. Method 4 is a combination of Methods 2 and 3. It is similar to Method 2 except that it is applied to five different ages at the same time and has some characteristics of Method 3 in that it uses annual crude mortality rates instead of central rates of mortality and produces one MMIF for each quinquennial group.

Conclusion

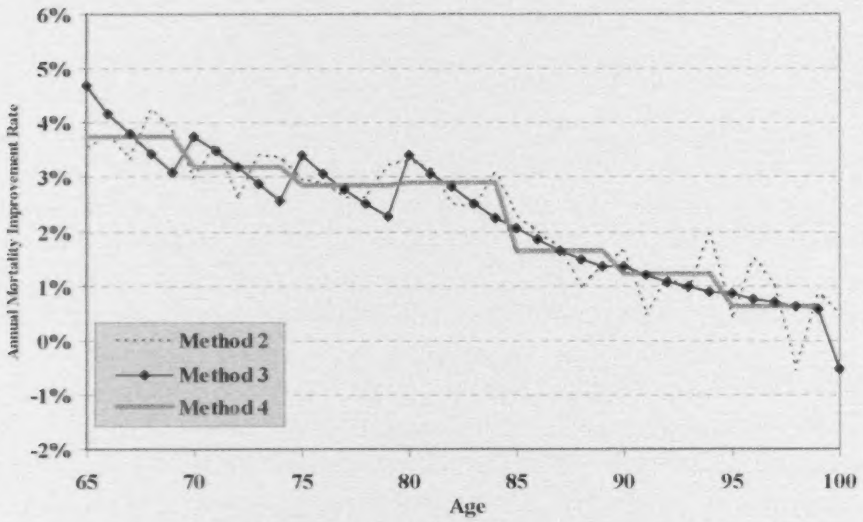
In summary, one of the problems with Method 2 is that it uses five data points to produce two values for a given age (x), a 2001 base year crude mortality rate and a MMIF. As a consequence, even though the 2001 base year crude rates obtained compared well to those produced under the other methods, the resultant MMIFs showed a wider fluctuation from age to age. As such, Methods 3 and 4 were considered superior because they produced six values while using twenty-five data points.

Although the four methods produce close results, Method 4 was chosen to estimate the 2001 base year crude mortality rates. Method 1 was not selected since it does not produce mortality improvement factors. Method 2 was not selected because, when compared to Methods 3 and 4, the improvement factors are less statistically significant when computed by age group since fewer data points are used. Although both Methods 3 and 4 are very good, Method 4 was ultimately selected because it uses annual crude rates based on product limit estimators.

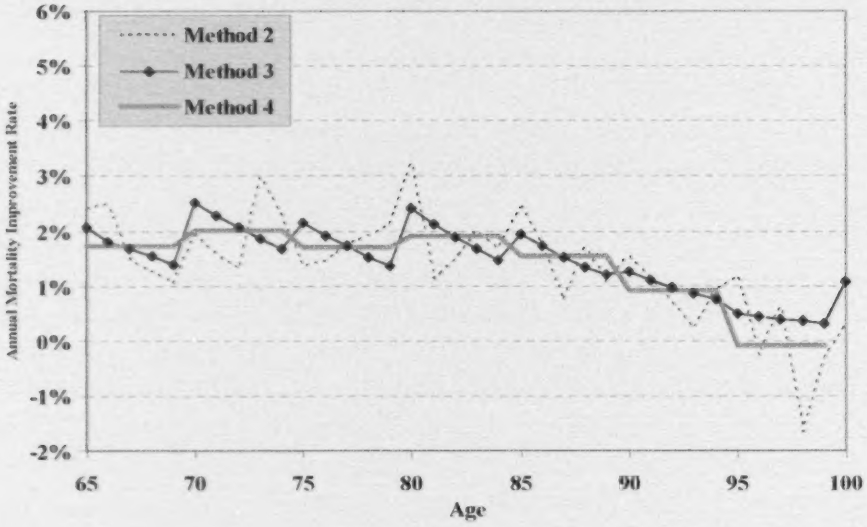
A comparison of the annual mortality improvement rates produced by each regression-based method (Methods 2, 3, and 4) is shown in Chart 19. All three methods show that, except at the very advanced ages, male improvement rates have been greater for females and exhibit a clearer declining pattern with age.

Chart 19 OAS Beneficiary Annual Mortality Improvement Rates by Method (2001)

Males



Females



D. Derivation of the Extension of Graduated Mortality Rates to Age 120

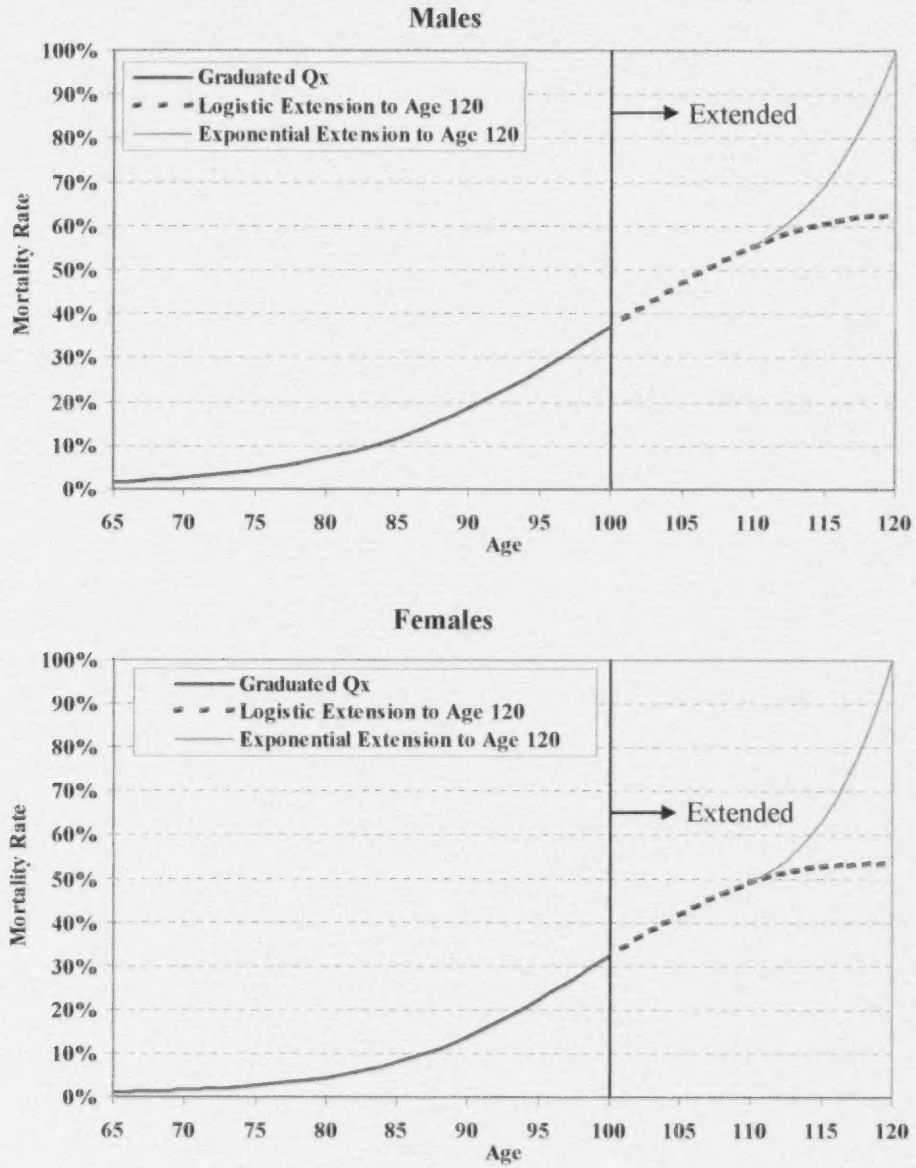
Two possible functions, one logistic and one exponential, were considered to extend the graduated rates from age 100 to age 120. Both are based on the use of linear relationships between $\ln(q_x/q_{x-1})$ and age (x), i.e., b + m(x), such that $q_x = q_{x-1} * e^{b+m(x)}$.

The curves of $\ln(q_x/q_{x-1})$ versus (x) based on the 2001 base year graduated mortality rates show a quasi-linear relationship between the ages 90 and 100. As such, it was decided to extend the mortality rates to age 120 using the same progression. The linear regressions are used to obtain linear parameters b and m for males and females separately. Extending the "natural" log-linear curves up to age 120, produced a resulting q_x curve that resembled an s-shaped curve familiar to the logistic family of curves.

The second method uses the natural progression of the log-linear relationships up to age 100 and then continues with a new log-linear curve up to age 120 with the additional constraint that the age 120 mortality rates would reach 1. The resulting q_x curve is of the exponential form.

After analyzing a pattern of mortality at the advanced ages, it was decided that the logistic function was a better choice since it better reflects rising mortality at diminishing rates at the advanced ages. The logistic and exponential projections of mortality for both sexes are shown in Chart 20.

Chart 20 Logistic and Exponential Extensions of Mortality Rates to Age 120 (2001)



E. Bibliography

Adam L., *Étude de Mortalité des Retraités du Régime de Rentes du Québec et du Régime de Pensions du Canada de 1967 à 2000* (2002).

Bourbeau R., Desjardins B., *Dealing with Problems in Data Quality for the Measurement of Mortality at Advanced Ages in Canada* (2001).

Broffitt J., *Maximum Likelihood Alternatives to Actuarial Estimators of Mortality Rates*, Transactions of Society of Actuaries 1984 Vol. 36.

Brown R.L., McDaid J., *Factors Affecting Retirement Mortality*, North American Actuarial Journal (April 2003).

Chen J., Wilkins R. and Ng E., *Health Expectancy by Immigrant Status, 1986 and 1991*. Health Reports, Winter 1996, Vol. 8, No. 3, Statistics Canada.

Held G., *Plastic Omega* (2001).

Hustead E., *Ending the Mortality Table* (2005).

Nault F., Roberge R., Berthelot J.-M., *Life Expectancy and Health Expectancy in Canada by Sex, Marital Status and Socioeconomic Status* (1996).

Robine J.-M., Cheung S.L.K., Paccard F., *Seasons and Longevity: Mortality Trajectories Among the Oldest Old* (2005).

Robine J.-M., Vaupel J.W., *Emergence of Supercentenarians in Low Mortality Countries* (2001).

Siegel J.S., *The Great Debate on the Outlook for Human Longevity: Exposition and Evaluation of two Divergent Views* (2005).

Statistics Canada, 2005, *Annual Deaths by Age Group and Sex*. CANSIM Table 102-0504.

Statistics Canada, 2005, *Annual Deaths by Age Group and Sex*. CANSIM Table 051-0002.

Thatcher A.R., *The Long-Term Pattern of Adult Mortality and the Highest Attained Age* (1999).

Trovato F., *Migration and Survival: The Mortality Experience of Immigration in Canada* (August 2003).

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